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INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

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

SUBJECT: PHYSICS - II (PH 121)

(NEW SCHEME-2015)

(BRANCH: COMMEN TO ALL)

Friday, 9 December 2016

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

- ✓ **Answer ANY FIVE full Questions.**
- ✓ **Any missing data may be suitably assumed**

PHYSICAL CONSTANTS

Elementary charge, e	:	1.602×10^{-19}C
Electron mass, m_e	:	9.11×10^{-31}kg
Boltzmann constant	:	1.38×10^{-23}J/K
Planck's constant	:	6.626×10^{-34}J.s
Stefan-Boltzmann constant	:	5.670×10^{-8} W/m^{2}K^4
Speed of light in vacuum	:	3.0×10^8m/s

1A. **(a)** The electrons in a particle beam each have a kinetic energy *K*. What are the magnitude and direction of the electric field that will stop these electrons in a distance *d?*

(b) Define electric flux.

A uniform electric field exists in a region of space in which there are no charges. What can you conclude about the net electric flux through a Gaussian surface placed in this region of space?

1B. State Gauss' law. Show that Coulomb's law can be deduced from Gauss's law. Apply Gauss' law to calculate the electric field (i) at a distance r from the line of charge (ii) near the surface of conductor.

1C. **(a)** A very long, straight, thin wire carries –3.60 nC/m of fixed negative charge. The wire is to be surrounded by a uniform cylinder of positive charge, radius 1.50 cm, coaxial with the wire. The volume charge density ρ of the cylinders to be selected so that the net electric field outside the cylinder is zero. Calculate the required positive charge densityρ.

(b) The drum of the photocopying machine has a length of 42 cm and a diameter of 12 cm. The electric field just above the surface of the charged drum has a magnitude E of 2.3×10^5N/C. (i) What is the surface charge density on the drum if it is a conductor? (ii) What is the total charge on the drum? (ii) 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?

[4 + 8 + 8]

2A. **(a)** Draw electric field lines and equipotential surfaces for an infinite sheet of charge.

(b) Two light bulbs both operate on 120 V. One has a power of 25W and the other 100W. Which bulb has higher resistance? Which bulb carries more current? Justify

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)** 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 **(i)** the final charge on and **(ii)** the potential of each sphere, assuming V = 0 at infinity.

(b) 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?

[4 + 8 + 8]

3A. **(a)** Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter D. Conductor B is a hollow tube of outside diameter 2D and inside diameter D. Find the resistance ratio, R_A/R_B, measured between their ends.

(b) If $\tau_{1/2}$ is the time interval required for the charge to fall to one half of its original value and τ is the time constant of a R-C circuit then show that $\tau_{1/2} = 0.693\tau$.

3B. Mention four applications of capacitors. Explain with relevant theory, how the capacitance of a parallel plate capacitor increases when **(i)** Filling the dielectric with battery connected, **(ii)** Filling the dielectric with battery disconnected.

3C. **(a)** 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 potential difference drops to 35.8 V. Find the capacitance of this second capacitor.

(b) Figure 1 shows a circuit with two loops. Find the currents in the circuit. The elements have the following values: $R_1 = 1.70\ \Omega$, $R_2 = 3.5\ \Omega$, $\mathscr{E}_1 = 2.1$ V $\mathscr{E}_2 = 6.3$V.

[4 + 8 + 8]

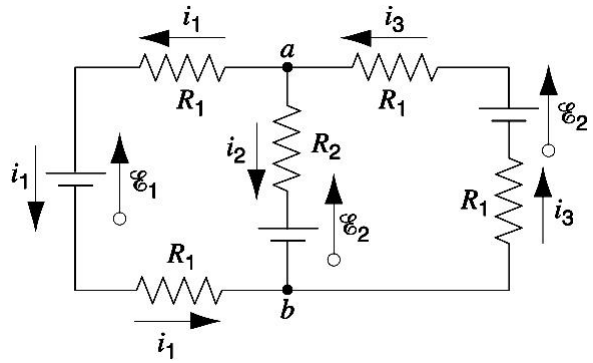

Figure 1

4A. **(a)** Explain Hall effect.

(b) How crossed electric and magnetic field will serve as velocity selector?

4B. What is cyclotron? Explain the construction and working of cyclotron. Discuss the resonance condition. Obtain the expression for energy obtainable.

4C. **(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) 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. **(i)** Find the magnetic force on each of the three sides of the loop. **(ii)** Show that the total magnetic force on the loop is zero.

[4 + 8 + 8]

5A. **(a)** Explain Biot Savart's law for the magnetic field of a current.

(b) Define one ampere based on the interaction between parallel currents.

5B. State ampere's law. Using this law find **(i)** magnetic fields at external and internal points of a long straight wire **(ii)** magnetic field of a ideal solenoid.

5C. **(a)** A long hairpin is formed by bending a piece of wire as shown in Fig. 2. If the wire carries a current i = 11.5 A, (a) what are the magnitude and direction of $\vec{B}$ at point a? (b) At point b, very far from a? Take R = 5.20 mm.

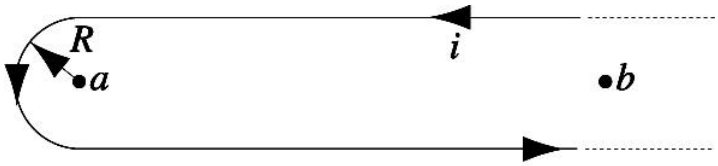

Figure 2

(b) 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.

[4 + 8 + 8]

6A. **(a)** Mention two advantages of eddy currents.

(b) Write two differences between induced electric field and electric field produced by charges.

6B. State **(i)** Faraday's law of electromagnetic induction **(ii**) Lenz' law. Obtain an expression for the power required to withdraw a closed conducting loop from a magnetic field. Show that the work done by the external agent is dissipated as Joule heating of the loop

6C. **(a)** You are given 52.5 cm of copper wire having a resistance of 9.34 mΩ. It is formed into a circular loop and placed at right angles to a uniform magnetic field that is increasing with time at the constant rate of 9.82 mT/s. At what rate is the internal energy generated in the loop?

(b) A circular loop made of a stretched conducting elastic material has a 1.23 m radius. It is placed with its plane at right angles to a uniform 785 mT magnetic field when released, the radius of the loop starts to decrease at an instantaneous rate 7.50 cm/s. Calculate the emf induced in the loop at that instant.

[4 + 8 + 8]

7A. **(a)** A switch controls the current in the circuit has large inductance. Is a spark more likely to be produced at the switch when the switch is being closed or when it is being opened, or doesn't it matters? Explain.

(b) You want to wind a coil so that it has resistance but no inductance. How would you do it?

7B. Explain with theory the variation of current and potential difference across the resistance and inductance of a series *LR* circuit.

7C. **(a)** The current in an LR circuit drops from 1.16 A to 10.2 mA in the 1.50 s immediately following removal of battery from the circuit. If L is 9.44 H, find the resistance R in the circuit.

(b) Compare the energy required to set up, in a cube 10cm on edge **(i)** a uniform electric field of 1.0×10^5 V/m and **(ii)** a uniform magnetic field of 1.0T.

[4 + 8 + 8]

8A. **(a)** The frequency of an LC oscillator is f_o. The plates of parallel plate capacitor are then pulled apart to twice the original distance. What is the new frequency of oscillation?

(b) If the load is strongly inductive, then the power delivered to the load can be maximized by increasing the capacitance of the circuit. Explain.

8B. A single loop circuit consisting of a resistor, a capacitor, an inductor and a source of alternating emf $\mathscr{E} = \mathscr{E}_m \sin\omega t$. Using trigonometric analysis find the amplitude of the current and the phase difference between current and voltage. Obtain the condition for resonance.

8C. **(a)** In a single loop RLC AC circuit, let R = 160 Ω, C = 15 μF, L = 230 mH, f = 60 Hz, and $\mathscr{E}_m$ = 36 V. Find **(i)** the inductive and capacitive reactance, **(ii)** the impedance Z for the circuit., **(iii)** the current amplitude i_m, and **(iv)** the phase constant ϕ.

(b) 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. **(i)** Calculate the impedance of the conditioner. **(ii)** Find the average power supplied to the appliance. **(iii)** What is the value of the rms current?

[4 + 8 + 8]