END SEMESTER EXAMINATION, JULY-2022

University Physics: Electricity & Magnetism (PHY2001)

Programme: B. Tech. **Semester: 2nd**
Full Marks: 60 **Time: 3 Hours**

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
PHY/ a,e	L_1, L_2, L_3	1	6
PHY/ a,e,g	L_1, L_2, L_3	2	6
PHY/ a,e,g	L_1, L_2, L_3	3	6
PHY/ a,e	L_1, L_2, L_3	4	6
PHY/ a,e	L_1, L_2, L_3	5	6
PHY/ a,e, g	L_1, L_2, L_3	6	6
PHY/ a,e,g	L_1, L_2, L_3	7	6
PHY/ a,e	L_1, L_2, L_3	8	6
PHY/ a,e,g	L_1, L_2, L_3	9	6
PHY/ a,e,g	L_1, L_2, L_3	10	6

*Bloom's taxonomy levels: Knowledge (L1), Comprehension (L2), Application (L3), Analysis (L4), Evaluation (L5), Creation (L6)

Answer all questions. Each question carries equal mark.

1. (a) Derive the electric field intensity at an axial point due to a uniformly charged ring and hence find $\vec{E}$ at the center of the ring. 2

   (b) Find the ratio of electrostatic force and gravitational force of attraction between an electron and proton pair where mass of electron $m_e = 9.1\times10^{-31} kg$ and mass of proton $m_p = 1.67\times10^{-27} kg$. 2

   $(G = 6.67\times10^{-11}\frac{N.m^2}{kg^2}$.

   (c) A solid metal sphere with radius 0.45m carries a net charge of $0.25nc$. Find the magnitude of the electric field (i) at a point 0.1m outside the surface of the sphere (ii) at a point 0.1m below the surface inside the sphere. 2

2. (a) Using gauss law derive electric field due to a uniformly charge distributed infinite linear conductor of linear charge density λ and hence show graphically how E varies with distance from the charged conductor. 2

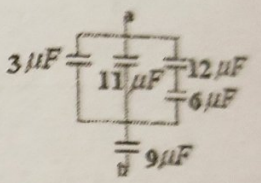
(b) If $\bar{E}$ at a certain point is zero, does the electric potential at that point have to be zero? Justify it through an example. 2

(c) A charge of $3.5nc$ is uniformly distributed over the surface of a metal sphere with a radius of 24cm. If the potential is zero at a point at infinity, find the value of the potential at the following distances from the center of the center of the sphere: (i) 48 cm and (ii) 12 cm. 2

3. (a) Derive an expression for the electric potential energy stored in a charged capacitor. 2

(b) The plates of a parallel plate capacitor in vacuum are 5 mm apart and $2m^2$ in area. A 10 KV potential difference is applied across the capacitor. Compute (i) Charge on each plate (ii) Magnitudes of the electric field between the plates. 2

(c) Find the equivalent capacitance across a and b, if the potential difference across a and b is 9V, find the charge across the $9\mu F$ capacitor. 2



4. (a) Rank the magnitude of the current from the highest to lowest value in the following circuits. (i) 1.4 Ω connected to 1.5 V battery with internal resistance r = 0.10 Ω (ii) 1.8 Ω connected to 4V battery having terminal voltage of 3.6V but with an unknown internal resistance. (iii) An unknown resistor connected to a 12V battery that has an internal resistance of 0.2 and terminal voltage of 11V. 2

(b) A battery of 24 V is connected to external resistance. If the terminal voltage of 24 V battery is 21.2V. Find (i) internal resistance (ii) external resistance. 2

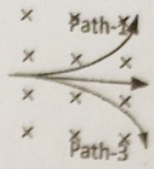
(c) You want to connect a 4μF capacitor and an 8μF capacitor. With which type of connection will the 4μF capacitor have a greater potential difference across it than the 8μF capacitor? 2

5. (a) Design how a 1 mA, 20 Ω ammeter can be used as an ammeter of 0-50mA range? 2

(b) A $1.5\mu F$ capacitor is charging through a 12Ω resistor using a 10V battery. At what time the capacitor will acquire ¼ of its maximum charge? 2

$r^2 \cos \sin^2\theta \sin^3\theta$

(c) A positive charge is injected with a horizontal velocity at $\vec{v}$ into a magnetic field which is normal and inward to the plane of the paper. Find the direction of force on charge particle and mention the path along which charged particle tends to move (i) Path 1 (ii) Path-2 (iii) Path-3.



6. (a) Discuss the motion of a charged particle in a uniform perpendicular magnetic field of 'B'. Derive the expression of radius (R) and frequency (f) of motion of charged particle where m, v, q are mass, velocity and magnitude of charge respectively.

(b) An electron experiences a magnetic force of $4.6\times10^{-15}N$ when moving at an angle 60° with respect to a magnetic field of $3.5\times10^{-3}T$. Find the speed of the electron.

(c) Derive briefly magnetic field due to straight current carrying conductor and discuss how magnetic field varies with distance from an infinite straight conductor carrying current and show it graphically.

7 (a) Two long parallel wire separated by 2.5 cm. Repulsive force per unit length exerted by one on other is $4\times10^{-5}N/m$. Current in one wire is 0.6A. (i) Find current in 2nd wire (ii) Direction of two current.

(b) Derive magnetic field at a centre of a circular coil carrying current if current through the coil is 10A having radius 10cm and no of turns 1000, find magnetic field at its centre.

(c) A single loop of wire with an area of $0.09m^2$ is in a uniform magnetic field that has an initial value of 3.80T, is perpendicular to the plane of the loop and is decreasing at a constant rate of 0.190 T/s. (i) What emf is induced in this loop. (ii) If the loop has a resistance of 0.6Ω Find the current induced in the loop.

8. (a) Derive an expression for instantaneous current during the **growth** of current in an R-L circuit

(b) A 35V battery, a 50 Ω resistor and 1.25 mH inductor with negl resistance are all connected in series with open switch. Swi suddenly closed find how long after closing the switch wi current through inductor reach ½ of its maximum value?

(c) Graphically represent the growth and decay of current in R-L circuit.

9. (a) An oscillating voltage of fixed amplitude is applied across a circuit element. If the frequency of this voltage is increased, will the amplitude of the current through the element (i) increase (ii) decrease or (iii) remains the same if it is (i) resistor and (ii) an inductor 2

(b) A series L-C-R circuit comprises of a L=60mH, C=0.50μF, R=300Ω are connected to an ac source of voltage V=50 volt and ω=10000 rad/s. Find (i) impedance of the circuit and (ii) expression of current. 2

(c) A $200\,\Omega$ resistor is connected in series with a $5\mu F$ capacitor, the voltage across the resistor is $v_R = 1.2\cos 2500t$ volt. (i) Write the expression for the circuit current and (ii) Impedance of circuit. 2

10 (a) (i) Is it possible to have a purely electric wave propagate through empty space that is a wave made up of an electric field but no magnetic field (ii) What about a purely magnetic wave with a magnetic field but no electric field? 2

(b) For an electromagnetic wave propagating through free space, calculate the frequency of a wave, with a wave length of (i) 300A (ii) 30m. 2

(c) Write down the Maxwell's four equations related between electric and magnetic field. 2

End of Questions