MID-SEMESTER EXAMINATION, May-2023

University Physics:Electricity & Magnetism (PHY2001)

Programme: B.Tech **Semester:2nd**
Full Marks: 30 **Time: 2 Hours**

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
CO-1: Able to comprehend Laws of electricity and magnetism Electromagnetic waves, active components of dc and ac circuits.	L_1, L_2	1(a), 2(a), 3(a), 4(a),5(a)	10
CO-2: Able to apply theoretical concepts and laws of electricity & magnetism to solve problems related to circuits analysis, electromagnetic theory and relevant engineering applications.	L_2, L_3	1(b), 2(b), 3(b), 4(b),5(b)	10
CO-3: Able to apply the fundamental laws of electromagnetism to give appropriate solutions to complex problems, design experiments and circuits, design small electrical equipments related to day to day life.	L_2, L_3	1(c), 2(c), 3(c), 4(c),5(c)	10

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

Answer all questions. Each question carries equal mark.

1.	(a)	Find the electric field at a point on the axis of a uniformly charged ring of radius 'a' at a distance 'x' from its centre.	2
	(b)	Two equal positive charges $q_1 = q_2 = 2\mu C$ are located at x = 0, y = 0.3m and x=0, y= – 0.3m, respectively. What are the magnitude and direction of the total electric force that q_1 and q_2 exert on a third charge $Q = 4\mu C$ located at x = 0.4m, y = 0.	2
	(c)	Evaluate 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 $m_p = 1.67\times10^{-27} kg$. ($G = 6.67\times10^{-11}\frac{N.m^2}{kg^2}$).	2

2.	(a)	Derive an expression for the electric field due to a uniformly charged non conducting sphere of radius R at a distance r from the centre of the sphere, where $r < R$.	2
	(b)	A point charge of -2.00 μC is located in the center of a spherical cavity of radius 6.50 cm inside an insulating charged solid. The charge density in the solid is $\rho = 7.35 \times 10^{-4}$ C/m^3. Calculate the electric field inside the solid at a distance of 9.50 cm from the center of the cavity.	2
	(c)	An amount of charge 'Q' is placed on an irregularly shaped conductor. Can it be possible to calculate the electric field at an arbitrary position outside the conductor applying the Gauss law if the shape and size of the conductor is known? Justify your answer.	2
3.	(a)	A solid conducting sphere of radius R has a total charge Q. Find the electric potential everywhere, both inside and outside the surface.	2
	(b)	A total electric charge of 3.5 nC is distributed uniformly over the surface of a metal sphere of radius 24 cm. Find the value of potential at the following distances from the centre of the sphere; (i) 48 cm and (ii) 12 cm.	2
	(c)	Graphically, show how the electric field and electric potential due to a charged conducting sphere vary with the distance 'r' from its centre.	2
4.	(a)	Derive the expression for energy stored in a capacitor with the space between the plates being vacuum. If a dielectric is inserted in between the plates keeping the charge on each plate constant, how will the stored energy be affected?	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)	You want to connect a 4 μF capacitor and an 8 μF capacitor. In which type of connection will the 4 μF capacitor have a greater amount of energy than that of 8 μF capacitor? Justify your answer.	2
5.	(a)	Express Ohm's Law in terms of electric field and current density. Hence derive the relation between potential difference across a conductor and the current flowing through it.	2

	(b)	Evaluate and rank the magnitude of the current from the highest to lowest value in the following circuits. (i) $1.4\,\Omega$ connected to 1.5 V battery with internal resistance r = $0.10\,\Omega$ (ii) $1.8\,\Omega$ 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 $0.2\,\Omega$ and terminal voltage of 11V.	2
	(c)	A radio receiver operating at 6 V draws a current of 0.1 A. How much electrical energy will it consume in 2 hours?	2
		End of Questions	