MID-SEMESTER EXAMINATION, MARCH-2020
University Physics: Electricity and Magnetism (PHY 2001)

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

Subject/Course Learning Outcome	*Taxonomy Level	Ques. Nos.	Marks
UPEM/ a, e	L_1, L_2, L_3	1	6
UPEM/ a, e, g	L_1, L_2, L_3	2	6
UPEM/ a, e, g	L_1, L_2, L_3	3	6
UPEM/ a, e	L_1, L_2, L_3	4	6
UPEM/ a, e, g	L_1, L_2, L_3	5	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 expression for torque on an electric dipole in a uniform external electric field.
   (b) An electric dipole is in a uniform electric field of magnitude 5×10^5 N/C. The charges on the dipole are $\pm 1.6 \times 10^{-19}$ C each and are separated by **0.125 nm**. Find the magnitude of electric dipole moment, potential energy and torque on the dipole if it makes an angle **145°** with the direction of electric field.
   (c) Discuss the equilibrium condition of an electric dipole when it is placed in a region of uniform electric field E, with the electric dipole moment P.
2. (a) Find the electric field due to a uniformly charged non conducting sphere at a distance 'r' from the centre of the sphere.
   (b) A solid metal sphere with radius **0.45 m** carries a net charge of **0.25 nC**. Find the magnitude of the electric field at a point **0.1 m** outside the surface of the sphere.
   (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.

3. (a) Electric charge 'Q' is distributed uniformly around a thin ring of radius 'a'. Find the electric potential at a point 'P' on the ring axis at a distance 'x' from the centre of the ring. 2

(b) A small particle has charge **-5μC** and mass 2.00×10^{-4} **kg**. It moves from point **A**, where the electric potential is $V_A = +200\,V$, to point **B**, where the electric potential is $V_B = +800\,V$. The electric force is the only force acting on the particle. The particle has speed **5.00 m/s** at point **A**. What is its speed at point **B**? 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) Find the capacitance of a parallel plate capacitor with its two plates each of area 'A' at a distance 'd' from each other. What change in its capacity do you expect if a dielectric is inserted between the plates? 2

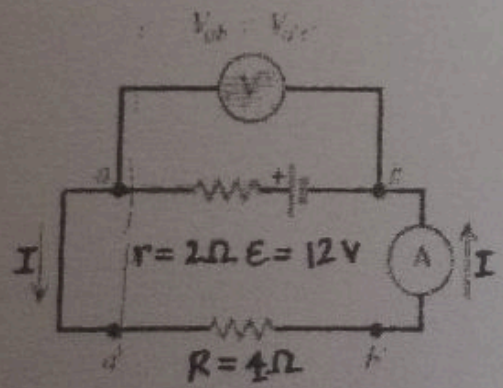
(b) The plates of a parallel-plate capacitor in vacuum are **5 mm** apart and $2m^2$ in area. A **10 kV** potential difference is applied across the capacitor. Compute (a) the capacitance; (b) the charge on each plate; and (c) the magnitude of the electric field between the plates. 2

(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) Derive the expression for current density in a conducting wire in terms of drift velocity of moving charges. 2

(b) A copper wire of diameter **1 mm** carries a current of **1.75 A** to a **200-W** lamp. The free electron density in the wire is $8.5 \times 10^{28}\ m^{-3}$. Find (i) the current density; and (ii) the drift velocity. 2

(c) 2



What are the voltmeter and ammeter readings in the above given circuits?