END SEMESTER EXAMINATION, APRIL-2018
UPEM (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	L_1, L_2, L_3	3	6
PHY/ a,e	L_1, L_2, L_3	4	6
PHY/ a,e,g	L_1, L_2, L_3	5	6
PHY/ a,e	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	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) Find the net force and torque on an electric dipole in a uniform external electric field. 2
   (b) An electric dipole is in a uniform electric field of magnitude $5x10^5 N/C$. The charges are $\pm$ 1.6×10^{-19} C each and are separated **by** 0.125 nm**.** Find the magnitude and direction of the electric dipole moment if it makes an angle 145^0 with the direction of electric field. 2
   (c) An electric dipole is placed in a region of uniform electric field ***E,*** with the electric dipole moment ***P***, pointing in the direction opposite to ***E***. Is the dipole (i) in stable equilibrium (ii) in unstable equilibrium (iii) neither? Justify. 2
2. (a) A charged conducting sphere of radius *R* has a total positive charge *q*. Find the electric field at any point inside and outside the sphere. 2
   (b) A solid metal sphere with radius 0.45 m carries a net charge of $0.25nC$. Find the magnitude of the electric field at a point 0.1 m outside the surface of the sphere. 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) 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) A ***10 μF*** capacitor is connected to a power supply that keeps a constant potential difference of ***24 V***. A dielectric material of dielectric constant ***3*** is inserted in between the plates completely filling the space between them. How much energy is stored in the capacitor before and after the dielectric is inserted? 2

(c) A capacitor has vacuum in the space between the conductors. If you double the amount of charge on each conductor, what happens to the capacitance? (i) increases; (ii) decreases; (iii) remains same. Justify your answer. 2

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

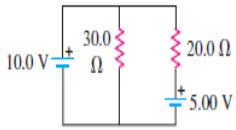
(b) A source of emf of ***24V*** is connected to an external resistance *R*. If the terminal voltage supplied by the source is ***21.2 V*** and current in the circuit ***4A***, find the external resistance *'R'* and internal resistance *'r'*. 2

(c) Rank the following circuits in order from highest to lowest current (i) ***1.4 Ω*** resister connected to a ***1.5 V*** battery that has an internal resistance of ***0.1 Ω***; (ii) a ***1.8 Ω*** resister connected to a ***4 V*** battery that has a terminal voltage of ***3.6 V*** but an unknown internal resistance. (iii) an unknown resister connected to a ***12 V*** battery that has a terminal voltage of ***11 V*** and internal resistance of ***0.2 Ω.*** 2

5. (a) State Kirchhoff's Junction and Loop Rule and mention their physical significance. 2

(b) What shunt resistance is required to convert a ***1 mA***, ***20 Ω*** galvanometer into ammeter of range ***0*** to ***50mA***? 2

(c) The batteries shown in the circuit in the figure have negligibly small internal resistances. Find the current through (a) the ***30 Ω*** resistor; (b) the ***20 Ω*** resistor; 2



6. (a) A capacitor of capacitance *C* connected with a resistor of resistance *R* is charged by a source of emf $\mathcal{E}$. Obtain the expression for instantaneous charge on the capacitor during charging. 2

(b) Show graphically the variation of charge *q* and current *i* with time when the capacitor is being charged in *RC* circuit. 2

(c) A ***10 MΩ*** resister is connected in series with a ***1 μF*** capacitor and a battery with emf ***12 V***. Before the switch is closed at time ***t = 0***, the capacitor is uncharged. Find the charge stored on the capacitor at ***t = 46s***. 2

7. (a) Find the expression for angular frequency of particles moving under the action of uniform magnetic field alone in nearly circular paths. 2

(b) If you double the speed of the charged particle in question (a) while keeping the magnetic field, charge and mass constant, how does this affect the radius of the trajectory and time required to complete one circular orbit. 2

(c) An electron experiences a magnetic force of magnitude 4.6×10^{-15} ***N*** when moving at an angle of 60^0 with respect to a magnetic field of magnitude 3.5×10^{-3} ***T***. Find the speed of the electron. Given the magnitude of charge for electron as $q = 1.6 \times 10^{-19}$ ***C.*** 2

8. (a) State Ampere's law and write its generalized form with help of displacement current. 2

(b) A cylindrical conductor with radius *R* carries a current *I*. The current is uniformly distributed over the cross-sectional area of the conductor. Find the magnetic field as a function of the distance r from the conductor axis for points both inside ($r < R$) and outside ($r > R$) the conductor. 2

(c) A closed curve encircles several conductors. The close line integral of magnetic field around this curve is 3.83×10^{-4} ***Tm***. (a) What is the current in the conductors? (b) If you were to integrate around the curve in the opposite direction, what would be the value of the line integral? 2

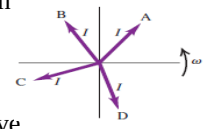
9. (a) Write Maxwell's four equations of electromagnetism and mention the symbols used in the equations. 2

(b) (i) Which of the Maxwell's equations explains how a credit card reader works? (ii) Which one describes how a wire carrying a steady current generates a magnetic field? 2

(c) The electric flux through a certain area of a dielectric is (8.76×10^3 Vm/s^4) t^4. The displacement current through the area id ***12.9 pA*** at time ***t = 26.1 ms***. Calculate the dielectric constant for the dielectric. 2

10 (a) Draw the phasor diagram for an *L-R-C* series circuit with an ac source and hence explain the expression for impedance of the circuit. 2

(b) The figure shows four different current phasors with the same angular frequency. At the time shown, which phasor corresponds to (i) positive current that is becoming more positive; (ii) a positive current that is decreasing toward zero; (iii) a negative current that is becoming more negative; (iv) a negative current that is decreasing in magnitude toward zero? 2



(c) In an *L-R-C* series circuit, suppose ***R = 250 Ω, L = 15 mH, C= 3.5μF***, ***V = 45 V and ω = 360 rad/s*** then what is the power factor of this circuit? 2

End of Questions