Class Test, First Semester, 2021
Course : Basic Electricity and Electrical Circuits (PHY 1211)
Dept. of CSE, University of Rajshahi

Time: 30 minutes
Marks: 15
Answer any *ONE* from each question

| | | | |
|---|---|---|---|
| 1 | (a) | Draw and define an electric dipole. | 3 |
| | (b) | Which type of charge distribution is Gauss's formula useful for? | 3 |
| 2 | (a) | Write down the equations for the electric field due to a point charge and a dipole. Mention and explain the cause(s) of difference between two equations. | 3 |
| | (b) | Find the expression for the electric field inside a spherical shell of charge with radius $R$ and total charge $q$. | 3 |
| 3 | (a) | Derive an expression for the torque exerted on an electric dipole placed in an electric field. | 5 |
| | (b) | Find the expression for the magnitude of electric field inside a uniform sphere of charge. | 5 |
| 4 | (a) | A neutral water molecule ($H_2O$) of electric dipole moment $6.2 \times 10^{-30}$ C.m is placed in an electric field of $1.5 \times 10^4$ N/C. What maximum torque can the field exert on it? | 4 |
| | (b) | A particle of charge $+q$ is placed at one corner of a Gaussian cube. What multiple of $q/\epsilon_0$ gives the flux through each cube face forming that corner? | 4 |

$T = PE\sin\theta$

Class Test 03, First Semester, 2021

Course : Basic Electricity and Electrical Circuits (PHY 1211)

Dept. of CSE, University of Rajshahi

Time: 30 minutes; Marks: 16

Answer any *ONE* question.

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1 (a) State and explain Ampere's law. 4

(b) Is Ampere's law suitable to use for all types of current distribution? Justify your answer. 3

(c) A long, straight wire of radius R carries a steady current I that is uniformly distributed through the cross section of the wire. Calculate the magnetic field a distance r from the center of the wire in the regions $r > R$ and $r < R$. 9

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2 (a) Show that the charge on the capacitor in an RC circuit increases according to $q = C\mathcal{E}(1 - e^{t/RC})$ 7

(b) Define capacitive time constant and show that it has the dimension of time. 3

(c) A capacitor of capacitance C that is being discharged through a resistor of resistance R. After how many time constants is the charge on the capacitor one-fourth its initial value? 6

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3 (a) State and explain Faraday's law of induction. 4

(b) Explain Lenz'z law. 2

(b) Define self and mutual induction. 4

(c) A coil consists of 200 turns of wire. Each turn is a square of side d 5 18 cm, and a uniform magnetic field directed perpendicular to the plane of the coil is turned on. If the field changes linearly from 0 to 0.50 T in 0.80 s, what is the magnitude of the induced emf in the coil while the field is changing? 6

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Answer question 1 and any one from 1 - 3.

1. What is the mean free time $\tau$ between collisions for the conduction electrons in copper? (conduction electron density and resistivity in copper are $8.49 \times 10^{28}$ m$^{-3}$ and $1.69 \times 10^{-8}$ $\Omega$.m). What is mean free path for the conduction electrons in copper, assuming that their effective speed $1.6 \times 10^{6}$ m/s. 4

2. (a) Discuss the effect of dielectric on the capacitance. 3
   (b) Discuss the effect of dielectric on the electric field. 3

3. (a) Derive Gauss's law with dielectrics. 6
   (b) Explain the electron theory of conductivity and derive the equation $\rho = \frac{m}{ne^2\tau}$. 6

4. (a) Why are small units used instead of Farad? 2
   (b) Define current and current density. 2