May 2024
B.Tech. (RAI) (Second Semester)
Physics (Electromagnetism and Basic Electronics) (BSC-101G)

Time : 3 *Hours*]   [*Maximum Marks* : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other. Use of Scientific Calculator is allowed.

Part A

1. (a) Find the volume charge density if the electric field in some region is found $E = kr^3\hat{r}$ in spherical coordinates (k is so me constant). **1.5**

   (b) Obtain the potential inside and outside a spherical shell whose radius is R, which carries a uniform surface charge. Set the reference point at infinity. **1.5**

(c) Two infinite parallel planes equal but opposite uniform charge densities $\pm\sigma$. Calculate the field between the two wires.

1.5

(d) Explain Ampere's law in magnetostatics.

1.5

(e) Discuss about the motional EMF in electrodynamics. **1.5**

(f) Two long parallel wire, each carrying current of 10 ampere in the same direction, are separated by 10 cm. Calculate the force between the wires per unit length. **1.5**

(g) What is the difference between Zener diode and simple p-n junction diode ? **1.5**

(h) $(2ED)_{16} = (\quad)_2 = (\quad)_8$ **1.5**

(i) Distinguish between analog and digital circuits. **1.5**

(j) Solve the given equation using Boolean Algebra $AB + B(B + \overline{C}) + \overline{B}C$. **1.5**

Part B

2. (a) Deduce Gauss's law in a differential form. Find the electric field inside a long cylinder carries a charge density that is proportional to the distance from the axis : $\rho = ks$, for some constant k. **10**

(b) Derive Poisson's and Laplace equations. Show that the potential function $V = a(x^2 + y^2 + z^2)$ does not satisfy Laplace's equation. **5**

3. (a) Discuss about the self and mutual inductance in electromagnetic induction. A short solenoid (length L and radius a with n_1 turns per unit length) lies on the axis of a very long solenoid (radius b, n_2 turns per unit length). Current I flow in the short solenoid. What is the flux through the long solenoid ? **10**

(b) Calculate the energy stored in a uniformly charged solid sphere of radius R and charge q. **5**

4. (a) What is Biot-Savart law ? Calculate the magnetic field at the centre of a circular loop of radius 5 cm, which carries a steady current 15 Ampere. **5**

(b) A steady current I flows down a long cylindrical wire of radius a. Find the magnetic field both inside and outside the wire if (i) The current is uniformly distributed over the outside surface of the wire. (ii) The current distributed in such a way that J is proportional to s, the distance from the axis.

5

(c) Find the electric dipole consists of two equal and opposite charges $(\pm q)$ separated by a distance d. Find the approximate potential and electric field at the points far from the dipole.

5

5. (a) What is p-type and n-type semiconductor ? Discuss about the mechanism of p-n junction diode and energy bands with energy level diagrams in forward and reverse biasing.

(b) Discuss with suitable diagram about the input and output I-V characteristics of CE configuration npn transistor as per the regions of operation.

5

6. (a) In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current.

5

(b) Explain, why NAND and NOR gates are known as universal gates.

5

(c) Convert :

(i) $(347)_{10} = (\ )_2 = (\ )_8$

(ii) $(11001.011)_2 = (\ )_{10} = (\ )_{16}$.

5

7. (a) Simplify the output expression :

$$Y = \overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$$

and implement the circuit for the final expression.

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(b) What are Basic logic gates ? Simplify Boolean function $Y = (\overline{A} + B)(A + B + D)\overline{D}$ and design circuit for the given expression.

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