7. (a) Simplify and draw a circuit for the output expression : 6

(i) $Y = (A\bar{B}(\bar{C} + BD) + \bar{A}\bar{B})C$

(ii) $Y = (\bar{A} + B)(A + B + D)\bar{D}$.

(b) Convert the following : 9

(i) $(2ED)_{16} = (\ )_8 = (\ )_2$

(ii) $(1101.011)_2 = (\ )_{10} = (\ )_{16}$

(iii) $(447)_{10} = (\ )_2 = (\ )_8$

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Roll No. .....

Total Pages : 06

020201

May 2026

B.Tech. (RAI) (Second Semester)

Physics (Electromagnetism and Basic Electronics)

(PHU-154-V)

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.

Part A

1. (a) What is Electrostatics ? 1.5

(b) Show that for external points, a spherical symmetric charge distribution behaves as if the entire charge were concentrated at the center. 1.5

(c) Prove that div B=0 and explain its significance. 1.5

(d) Using Ampere's law find the magnetic field a distance s from a long straight wire carrying a steady current I. 1.5

(e) What do you understand by the term motional electromotive force ? 1.5

(f) Write integral form of Maxwell's equations in electrodynamics. 1.5

(g) What do you mean by Voltage Regulation in diodes ? 1.5

(h) Using Boolean rules prove that : 1.5

$$A+\bar{A}B=A+B$$

(i) What is the difference between analog and digital circuits ? 1.5

(j) $(3AC)_{16} = (\quad)_{10}$ 1.5

Part B

2. (a) Discuss about the field lines, flux and Gauss's law in electrostatic. 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. 8

(b) Discuss briefly about Poisson's and Laplace equations. In a region of free space ($\varepsilon_0 = 8.85 \times 10^{-12}$ F/m), the electric potential is given by the function : $V = 4yz/(x^2 + 1)$ Volts. Calculate the volume charge density ρ at point P (1, 2, 3). 7

3. (a) To Show that the potential energy of the system of charges can be calculated from electric field by assigning an amount of energy $(1/2)\varepsilon_0 E^2 d\tau$ to every volume element $d\tau$ and integrated over entire space. 5

(b) Find an expression for electric potential inside and outside a spherical shell of radius R, which carries a uniform surface charge. Set the reference point at infinity. 5

(c) State and prove Ampere's Circuital law. Starting from Ampere's circuital law, establish the relation $\nabla \times B = \mu_0 J$. 5

4. (a) State Biot-Savart's law and find an expression for the magnetic field (B) at the centre of a square of side '*a*' carrying a steady current 'I' 7

(b) Discuss about self and mutual inductance in electromagnetic induction. Find the self-inductance per unit length of a solenoid of radius R carrying *n* turns per unit length. 8

5. (a) Discuss about the concept of displacement current and show that Curl $H = J + J_d$. Write Maxwell's equation in vacuum and non-conducting medium as well. 5

(b) What is *p*-type and *n*-type semiconductor ? Discuss about the mechanism of *p-n* junction diode with the help of energy level diagrams in forward and reverse biasing. 10

6. (a) Discuss with suitable diagram about the input and output I-V characteristics of CE configuration *npn* transistor as per the regions of operation. Calculate emitter current I_E in a transistor for which $\beta = 50$ and $I_B = 20\ \mu A$. 8

(b) Discuss about the NAND and NOR gates with suitable diagram and truth table. Combine NAND and NOR gates to create a circuit for a 3-input AND gate. 7