2022

(November)

PHYSICS

(Honours)

[PHY–06 (T)]

(Electrodynamics, Electronics—II)

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** and *any* **four** from the rest

1. *(a)* The data sheet for a certain JFET indicates that $I_{DSS} = 16$ mA and $V_{GS(off)} = -5$ V. Determine the drain current I_D for $V_{GS} = 0$ V, –1 V.   2+2=4

   (b) Prove the following identity :   3

   $$(A + B)(A + C) = A + BC$$

   (c) Convert 0.8125_{10} into its binary equivalent.   3

   (d) Using 2's complement, subtract $(1010)_2$ from $(1101)_2$.   2

(2)

2. *(a)* State and prove uniqueness theorem in relation to electric potential.   5

(b) Assuming $\vec{B}$ to be a function of time, show that

$$\nabla^2 \vec{B} = \mu_0 \varepsilon_0 \frac{\partial^2 B}{\partial t^2}$$

where μ_0 and ε_0 represent the permeability and permittivity of free space respectively.   3

(c) Define the terms dielectric constant K and electric susceptibility χ_e. Show that $K = 1 + \chi_e$.   1+1+1=3

3. *(a)* Establish the boundary conditions satisfied by $\vec{E}$ and $\vec{D}$ at the interface between two homogeneous and isotropic dielectrics.   6

(b) Derive Clausius-Mosotti equation.   5

4. *(a)* What are gauge transformations? Discuss the significance and utility of Coulomb's gauge in dealing with inhomogeneous wave equation.   2+5=7

(b) Show that the electric and the magnetic field vectors in an e.m. wave are mutually perpendicular.   4

(3)

5. *(a)* Define Poynting vector and discuss its physical significance.   2+2=4

(b) Illustrate with necessary theory the propagation of plane electromagnetic waves in an isotropic dielectric medium.   7

6. *(a)* What are FETs? Why is a forward bias not applied to the gate of a JFET? Draw a circuit diagram for obtaining the static characteristic of an n-channel JFET and also draw the typical static characteristics.   1+2+2=5

(b) Explain the working of an OP-AMP as an adder.   4

(c) What is meant by CMRR of an OP-AMP?   2

7. *(a)* Draw a neat circuit diagram of a two-stage R-C coupled transistor amplifier and explain its working. Show that the voltage gain of an R-C coupled amplifier in the mid-frequency range is independent of frequency.   1+2+4=7

(b) Draw the circuit diagram of a Colpitts oscillator.   1

(c) Prove the Boolean identity

$$(A+B)(A+\bar{B})(\bar{A}+C) = AC$$ 3

8. *(a)* Explain the following statements in FORTRAN : $2 \times 3 = 6$

    (i) DIMENTION statement

    (ii) FORMAT statement

    (iii) END statement

(b) Develop the relevant flowchart and an algorithm for finding out the real, equal and imaginary roots of the equation $ax^2 + bx + c = 0$, where a, b and c are constants. $2 + 3 = 5$

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