

5/H-24 (vi) (Syllabus-2015)

2019

(October)

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, which is compulsory
and any four from the rest**

1. (a) Dielectric constant of a gas at NTP is 1.000074. Calculate (i) the induced dipole moment per unit volume and (ii) dipole moment per atom of the gas, when it is held in an external electric field of $3 \times 10^4 \text{ V/m}$. 2+2=4
- (b) A differential amplifier has an open circuit voltage gain of 100. The amplifier has a common input signal of 3.2 V to both terminals. This results in an output signal of 26 mV. Determine (i) the common-mode voltage gain and (ii) the CMRR in dB. 2+2=4

(Turn Over)

(2)

- (c) Evaluate the following arithmetic FORTRAN statement for $I = 5$, $J = 7$ and $K = 10$

$$X = I * I / J - K * 2 / I$$

2

- (d) Simplify the following Boolean expression :

2

$$Y = 1 + A(B \cdot \bar{C} + BC + \bar{B}\bar{C}) + A\bar{B}C + AC$$

2. (a) Write down Maxwell's equations in free space. Identify the symbols and give their empirical basis.

3

- (b) Define the terms dielectric constant k and electric susceptibility χ_e . Prove the relation $k = 1 + \chi_e$.

$$1 + 1 + 2 = 4$$

4

- (c) Derive Clausius-Mossotti equation.

3. (a) Derive an expression for Gauss's law in a dielectric medium.

3

- (b) What are magnetic scalar potential ϕ and magnetic vector potential \vec{A} ? If at any position the magnetic vector potential is $\vec{A} = 5(x^2 + y^2 + z^2)\hat{i}$, evaluate the magnetic field at that position.

$$2 + 2 = 4$$

- (c) If \vec{A} represents the magnetic vector potential and \vec{J} the current density vector, then show that $\vec{\nabla}^2 \vec{A} = -\mu_0 \vec{J}$ and identify the equation.

4

4. (a) Discuss the theories of reflection and transmission of a plane e.m. wave at a boundary of two dielectrics.

6

(3)

- (b) Considering normal incidence of electromagnetic waves at the boundary between two dielectric media, derive the expressions for reflectance and transmittance.

5

5. (a) State two points of similarities and dissimilarities each between JFET and BJT. Explain the terms pinch-off voltage and shorted-gain drain current in a JFET circuit.

$$2 + 2 + 2 + 2 = 8$$

- (b) What is a MOSFET? Mention its types.

$$2 + 1 = 3$$

6. (a) What is an operational amplifier (OP-AMP)? Draw the basic circuit of a differential amplifier and discuss its operation.

$$2 + 2 + 2 = 6$$

- (b) What are gauge transformations? Discuss the significance of Lorentz gauge.

$$2 + 3 = 5$$

7. (a) With the help of a neat circuit diagram, explain the working of a Colpitts' oscillator. Write the expression for the frequency of oscillations for it.

$$2 + 2 + 1 = 5$$

- (b) Using two's complement scheme, perform the following binary subtraction

$$1110011 - 1001111$$

1

- (c) Convert $(43.812)_{10}$ to binary.

1

- (d) What is a digital comparator? Draw a 1-bit digital comparator.

2

(Turn Over)

- (e) Explain the working of a multiplexer with the help of a logic circuit of 'two line to one line' multiplexer. 2
8. (a) Draw a flowchart for solving a quadratic equation. Develop an algorithm for the same and hence write a program in FORTRAN to solve a quadratic equation. $2+2+2=6$
- (b) Explain the usage of the following input-output statements in FORTRAN
- (i) GO TO
- (ii) IF THEN, ELSE, ENDIF $1\frac{1}{2}+1\frac{1}{2}=3$
- (c) What are non-executable statements in FORTRAN programming? Explain any one with example. $1+1=2$
9. (a) Explain with examples (i) double-precision variable and (ii) logical constant. $1\frac{1}{2}+1\frac{1}{2}=3$
- (b) What are executable statements in FORTRAN programming? List a few and explain any one of them. $1\frac{1}{2}+1\frac{1}{2}=3$
- (c) Explain with illustration formatted and unformatted output statements in FORTRAN. $2+2=4$
- (d) Explain any one of the following FORTRAN statements : 1
- (i) COMMON
- (ii) DIMENSION

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