III/ PHY (iii) (PR)

2 0 1 6

(3rd Semester)

PHYSICS

THIRD PAPER (PH–301)

(Electromagnetism, Quantum Mechanics–I and Electronics–I)

(Pre-revised)

Full Marks : 55

Time : $2\frac{1}{2}$ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* State and prove Green's theorem. 1+4

(b) Find the unit normal to the surface $x^2y + 2xz = 4$ at the point (2, −2, 3). 2

Or

(a) What do you mean by a Gaussian surface? State and prove Gauss theorem. 1+1+3

(b) A point charge of 11 C is placed at the centre of a cube of side 5 cm. Calculate the electric flux through each surface. 2

2. *(a)* What is a capacitor? Derive an expression for energy stored per unit volume in a parallel-plate capacitor. 1+2

(b) Derive the relationship among $\vec{E}$, $\vec{P}$ and $\vec{D}$. 4

Or

(a) Derive an expression for charge q on a capacitor C at any time t when the capacitor is charged in a C-R circuit. 4

(b) A capacitor of capacitance 1 μF is allowed to discharge through an inductance of 0·2 H and a resistance of 800 Ω connected in series. Prove that the discharge is oscillatory. 3

3. *(a)* Define resonance as applied to an electrical circuit. Find the condition for resonance in a series L-C-R circuit. Obtain an expression for current at resonance. 1+3

(b) Define root-mean-square value of an alternating current and hence deduce an expression for it for an alternating current represented by $I = I_0 \sin \omega t$. 3

Or

(a) Show that the line integral of the magnetic field over a closed path is independent of the shape of the path. 4

(b) In an hydrogen atom, the electron circulates around the nucleus in a circular orbit of radius $5 \cdot 1 \times 10^{-11}$ m at a frequency of $6 \cdot 8 \times 10^{15}$ rev/sec.

(i) What is the value of magnetic field $\vec{B}$ at the centre of the coil?

(ii) What is the equivalent magnetic dipole moment? 2+1

4. *(a)* State the assumptions of Planck's law of black-body radiation. Deduce Wien's law and Rayleigh-Jean law using Planck's radiation law. 1+2

(b) Show that for a photon of frequency ν, the associated wavelength is given by

$$\lambda = \frac{h}{p}$$

where p is the momentum. 2

(c) Calculate the de Broglie wavelength of an α-particle accelerated through a potential difference of 2000 V. 2

Or

(a) Using Heisenberg's uncertainty principle, find the radius of the hydrogen atom in the ground state. 3

(b) What do you mean by normalization of a wave function? The normalized ground state wave function of an electron in a hydrogen atom is given by

$$\psi(\vec{r}) = \left(\frac{1}{\pi a_0^3}\right)^{1/2} e^{-\frac{r}{a_0}}$$

where a_0 is the first Bohr radius. Verify that $\psi(\vec{r})$ is normalized. 1+3

5. *(a)* Explain the phenomenon of Hall effect with a neat diagram. Derive an expression for Hall voltage and hence show that the Hall coefficient

$$R_{\mathrm{H}} = \frac{1}{ne}$$ 5

(b) The current gain of a transistor in CE configuration is 49. What will be the current gain of the same transistor in CB configuration? 2

Or

Discuss the working of a transformer-coupled transistor amplifier with the help of a circuit diagram. Draw and explain the frequency-response curve. Mention two advantages of transformer-coupled transistor amplifier. 4+2+1

★★★

Subject Code :

III/PHY (iii) (PR)

Booklet No. A

Date Stamp ....

....

To be filled in by the Candidate

DEGREE 3rd Semester
(Arts / Science / Commerce /
.......................) Exam., **2016**

Subject ....
Paper ....

To be filled in by the Candidate

DEGREE 3rd Semester
(Arts / Science / Commerce /
.......................) Exam., **2016**

Roll No. ....
Regn. No. ....

Subject ....
Paper ....

Descriptive Type
Booklet No. B ....

INSTRUCTIONS TO CANDIDATES

1. **The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
2. **This paper should be ANSWERED FIRST and submitted within** *45 minutes* **of the commencement of the Examination.**
3. **While answering the questions of this booklet, any cutting, erasing, over-writing or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

/54

2 0 1 6

(3rd Semester)

PHYSICS

THIRD PAPER (PH–301)

(Electromagnetism, Quantum Mechanics–I and Electronics–I)

(Pre-revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×5=5

1. The electric field at a point P on the surface of a solid cylinder of radius a with charge per unit length λ is given by

(a) $\dfrac{\lambda}{\varepsilon_0 a}$ ( )

(b) $\dfrac{\lambda}{2\varepsilon_0 a}$ ( )

(c) $\dfrac{\lambda}{2\pi\varepsilon_0 a}$ ( )

(d) $\dfrac{2\lambda}{\varepsilon_0 a}$ ( )

2. The degree of alignment of polar molecules depends upon

(a) the intensity of the applied electric field ( )

(b) the temperature of the dipoles ( )

(c) Both *(a)* and *(b)* ( )

(d) magnetic moment ( )

3. Two parallel wires carrying currents flowing in opposite directions will

(a) repel each other ( )

(b) attract each other ( )

(c) neither repel nor attract ( )

(d) neutralize each other ( )

4. A stationary state is that for which the probability of finding the particle at a point in space is

(a) dependent on t ( )

(b) independent of t ( )

(c) dependent on x ( )

(d) independent of x ( )

5. A Zener diode can be used as

(a) an oscillator ( )

(b) a rectifier ( )

(c) a transmitter ( )

(d) a voltage regulator ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. If the line integral of a vector $\vec{A}$ around a closed curve is equal to the surface integral of the vector $\vec{B}$ taken over the surface bounded by the given closed curve, then show that $\vec{B} = \text{curl}\,\vec{A}$.

2. State and explain Norton's theorem.

3. Obtain the expression for torque on a current loop placed in a magnetic field $\vec{B}$.

4. The work function of a tungsten surface is 6 eV. When the surface is illuminated by the light of wavelength 155·5 nm, the maximum photoelectron energy is 2 eV. Find Planck's constant from these data.

5. Explain the formation of depletion layer in a *p*-*n* junction.

★★★