V/ PHY (v) (PR)

2016

(5th Semester)

PHYSICS

FIFTH PAPER

(Mathematical Physics—I)

(Pre-revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Explain the meaning of ordinary point of differential equation by giving an example. 2

(b) Find the power series solution of $(1 \quad x^2)y \quad 2xy \quad 2y \quad 0$ about $x \quad 0$. 8

Or

Use the method of separation of variables to solve the equation $\frac{v}{x^2} \quad \frac{v}{t}$. Given that $v \quad 0$ at $x \quad 0$ and $x \quad l$, $v \quad 0$ at $t \quad$. 10

2. *(a)* Show that $P_n(x) \quad \frac{1}{2^n (n!)} \frac{d^n}{dx^n}(x^2 \quad 1)^n$. 5

(b) Express the function

$$f(x) \quad 4x^3 \quad 6x^2 \quad 7x \quad 2$$

in terms of Legendre's polynomials. 5

Or

(a) For Hermite polynomials $H_n(x)$, show that $H_n(x) \quad 2nH_{n \quad 1}(x)$. 3

(b) Prove the following : 3½+3½=7

(i) $xJ_n(x) \quad nJ_n(x) \quad xJ_{n \quad 1}(x)$

(ii) $2J_n(x) \quad J_{n \quad 1}(x) \quad J_{n \quad 1}(x)$

3. *(a)* What do you mean by Argand diagram? What is the modulus of the complex number $a \quad ib$? 2

(b) Deduce the Cauchy-Reimann conditions for the analyticity of a function of complex variable. 4

(c) State and prove Cauchy integral theorem. 4

Or

(a) Find the first four terms of the Taylor's series expansion of the complex variable function

$$f(z) \quad \frac{z \quad 1}{(z \quad 3)(z \quad 4)}$$

about $z \quad 2$. 5

(b) By using residue theorem, show that

$$\int_0^{2} \frac{d}{2 \quad \cos} \quad \frac{2}{\sqrt{3}}$$ 5

4. *(a)* Discuss the two sets of unit vectors in a curvilinear coordinate system (u_1, u_2, u_3). 4

(b) Deduce the expressions for the divergence and curl of a vector field in cylindrical coordinates. 6

Or

(a) What are symmetric and skew-symmetric tensors? Show that every tensor of rank 2 can be expressed as the sum of symmetric and skew-symmetric tensors. 2+3=5

(b) If A and B are the components of a contravariant and covariant tensors of rank 1 each, show that $C \quad A \ B$ are the components of a mixed tensor of rank 2. 3

(c) Write the transformation relation for the following tensors : 2

(i) A and *(ii)* A

5. *(a)* Show that the transpose of the product of two matrices is the product of their transposes taken in the reverse order, i.e., $(AB)^T \quad B^T A^T$, where T denotes transpose. 3

(b) Solve the following simultaneous equations by matrix method : 5

$$2x \quad 3y \quad 4z \quad 9$$
$$2y \quad 3z \quad 8$$
$$x \quad z \quad 3$$

(c) What are orthogonal and unitary matrices? 2

Or

(a) Find the eigenvalues and eigenvectors of the matrix $\begin{matrix} 0 & i \\ i & 0 \end{matrix}$. 5

(b) The matrix $A \quad \begin{matrix} a & h \\ h & b \end{matrix}$ is transformed to the diagonal form $D \quad T^{\ 1}AT$, where

$$T \quad \begin{matrix} \cos & \sin \\ \sin & \cos \end{matrix}$$

Find the value of , which gives the diagonal transformation. 5

★ ★ ★

Subject Code : V/ PHY (v) (PR)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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 1 (one) Hour 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)*

2016

(5th Semester)

PHYSICS

FIFTH PAPER

(Mathematical Physics—I)

(Pre-revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

1. If a function of two variables is a solution of Laplace's equation, the function is said to be

(a) conjugate ( )

(b) harmonic ( )

(c) anharmonic ( )

(d) discontinuous ( )

2. In the differential equation

$$(1-x^2)y'' - 2xy' + l(l+1)y = 0$$

(a) $x = 0$ is an ordinary point ( )

(b) $x = \pm 1$ are regular singular points ( )

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

(d) $x = \pm 2$ are regular singular points ( )

3. For integral values of n, $J_n(-x)$ is

(a) $(-1)^n J_n(x)$ ( )

(b) $J_n(x)$ ( )

(c) 0 ( )

(d) $(-1)^n \pi J_n(x)$ ( )

4. The value of $H_2(x)$ is

(a) $x^2 - 1$ ( )

(b) $2x^2 - 1$ ( )

(c) $4x^2 - 2$ ( )

(d) $\frac{1}{2}(3x^2 - 1)$ ( )

5. The equation for a circle with centre at $(-1, 1)$ and radius 3 is

(a) $|z+1+i|=3$ ( )

(b) $|z+1-i|=3$ ( )

(c) $|z-1-i|=3$ ( )

(d) $|z-1+i|=3$ ( )

6. The function $\frac{1}{(z-1)^{1/2}}$

(a) is analytic in the region $|z|<2$ ( )

(b) has a pole at $z=1$ ( )

(c) has a branch point at $z=1$ ( )

(d) has an essential singularity at $z=1$ ( )

7. Rotation of a point (0, 1) using the matrix

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

about the origin through an angle $\frac{\pi}{4}$ results in a point

(a) $\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ ( )

(b) $\left(\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$ ( )

(c) (1, 0) ( )

(d) (0, −1) ( )

8. Rank of $n \times m$ matrix is the

(a) largest square submatrix with non-zero determinant ( )

(b) number of columns in $n \times m$ matrix ( )

(c) number of rows in $n \times m$ matrix ( )

(d) largest square submatrix with zero determinant ( )

9. In cylindrical coordinate system, the intersection between coordinate surfaces $\rho = c_1$ and $z = c_3$ is a/an

(a) straight line ( )

(b) circle ( )

(c) semicircle ( )

(d) ellipse ( )

10. If x^i, $i = 1, 2$ represents rectangular coordinates, the relation $x^i x^i = 1$ would represent

(a) a circle of unit radius ( )

(b) a sphere of unit radius ( )

(c) a straight line in two dimensions ( )

(d) a hypersphere of unit radius ( )

SECTION—II

(*Marks* : 15)

Give short answers to the following questions : 3×5=15

1. Find the differential equation for which the solution is $y = c_1 e^{x} + c_2 e^{-x} + 3x$.

2. Using Rodrigues formula, prove that

$$\int_{-1}^{+1} P_0(x)dx = 2$$

3. Using residue theorem, evaluate the integral $\int_C \frac{1+z}{z(2-z)}\,dz$, where the circle C is $|z|=1$.

4. Explain Einstein's summation convention. Give an example.

5. What do you mean by row, column and symmetric matrices? Give one example each.

★★★

V/PHY (v) (R)

2016

(5th Semester)

PHYSICS

FIFTH PAPER

(Mathematical Physics—I)

(Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Evaluate the integral

$$\int_0 e^{-ax} x^{m-1} \cos bx \, dx \qquad 4$$

(b) Prove that

$$(m) \quad m - \frac{1}{2} \quad \frac{\sqrt{\ }}{2^{2m-1}} \quad (2m) \qquad 6$$

Or

(a) Show that 3+3=6

(i) $\int_0^{/2} \frac{d}{\sqrt{\sin}} \quad \int_0^{/2} \sqrt{\sin} \, d$

(ii) $\int_0 \frac{x^8(1 \quad x^6)}{(1 \quad x)^{24}} dx \quad 0$

(b) Starting with the definition of -function, show that $\frac{1}{2} \quad \sqrt{\ }$. 4

2. *(a)* Show that the function $f(z) \quad u \quad iv$, where

$$f(z) \quad \frac{x^3(1 \quad i) \quad y^3(1 \quad i)}{x^2 \quad y^2}; \ (z \quad 0), \ f(0) \quad 0$$

is continuous and that the Cauchy-Riemann equations are satisfied at the origin yet f (0) does not exist. 5

(b) State Taylor's series theorem. Expand

$$f(z) \quad \frac{z \quad 1}{(z \quad 3)(z \quad 4)}$$

about $z \quad 2$. 1+4=5

Or

(a) State and prove Cauchy's residue theorem. 5

(b) Using Cauchy's integral theorem, integrate $\frac{z^2 \quad 1}{z^2 \quad 1}$ along a circle of radius 1 with centre at *(i)* $z \quad 1$ and *(ii)* $z \quad i$. 2½+2½=5

3. *(a)* Show that the transpose of the product of two matrices is the product of their transposes taken in the reverse order i.e., $(AB)^T \quad B^T A^T$, where T denotes transpose. 3

(b) If H is a Hermitian matrix, show that e^{iH} is a unitary matrix. 3

(c) Show that any two eigenvectors corresponding to two distinct eigen-values of a Hermitian matrix are orthogonal. 4

Or

(a) Find the eigenvalues and eigenvectors of the matrix $\begin{matrix} 1 & 2 \\ 3 & 2 \end{matrix}$. 5

(b) The matrix $A \quad \begin{matrix} a & h \\ h & b \end{matrix}$ is transformed to the diagonal form $D \quad T^{\ 1}AT$, where

$$T \quad \begin{matrix} \cos & \sin \\ \sin & \cos \end{matrix}$$

Find the value of , which gives the diagonal transformation. 5

4. *(a)* Find the scale factors for cylindrical coordinate systems. Express $\vec{\ } . \vec{A}$ in cylindrical coordinates. 3+2=5

(b) Show that unit vectors in spherical polar coordinate system are related to unit vectors in Cartesian coordinate system as

$$\begin{matrix} \hat{r} & \sin\cos & \sin\sin & \cos & \hat{i} \\ \hat{} & \cos\cos & \cos\sin & \sin & \hat{j} \\ \hat{} & \sin & \cos & 0 & \hat{k} \end{matrix} \quad 5$$

Or

(a) Show that every tensor of rank 2 can be expressed as the sum of symmetric and skew-symmetric tensor. 2

(b) Show that $\frac{A_i}{x_j}$ is not a tensor although A_i is a covariant tensor of rank one. 3

(c) Show that the contraction of the tensor A_q^p is a scalar. 3

(d) Write the transformation relation for the following tensors : 2

(i) A and *(ii)* B

5. *(a)* Explain in briefly about standard input/output stream of C++ with examples. 3

(b) Write an appropriate C++ statement for each of the following : 3

(i) Read the values of *a*, *b* and *c*

(ii) Write the values of *a* and *b* in one line followed by the value of *c* on another line

(iii) Write the values of *a* and *b* in one line separated by blanks and value of *c* after two blank lines

(c) Write a C++ program that reads two values *x* and *y*, exchanges their contents and prints the output. 4

Or

(a) With the help of appropriate flowchart diagram, describe how 'if', 'if else' and 'nested if' control statements are executed in C++ program. 6

(b) Using 'nested if' control statement, write a program that will find and print the greatest of three numbers. 4

★ ★ ★

Subject Code : V/ PHY (v) (R)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

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 1 (one) Hour 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.**

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

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

Subject .....
Paper .....

Descriptive Type
Booklet No. B .....

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

2016

(5th Semester)

PHYSICS

FIFTH PAPER

(Mathematical Physics—I)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

1. The value of ratio $\frac{\Gamma(1)}{\Gamma(0)}$ is

(a) 1 ( )

(b) ∞ ( )

(c) 0 ( )

(d) $\frac{2}{3}$ ( )

2. The value $\beta(z, 1)$ is

(a) $\frac{1}{z}$ ( )

(b) $\frac{1}{(z+1)}$ ( )

(c) $\frac{1}{z(z+1)}$ ( )

(d) $\frac{z}{(z+1)}$ ( )

3. The equation for a circle with centre at $(-1, 1)$ and radius 3 is

(a) $|z+1+i|=3$ ( )

(b) $|z+1-i|=3$ ( )

(c) $|z-1-i|=3$ ( )

(d) $|z-1+i|=3$ ( )

4. The function $\frac{1}{(z-1)^{1/2}}$

(a) is analytic in the region $|z|<2$ ( )

(b) has a pole at $z=1$ ( )

(c) has a branch point at $z=1$ ( )

(d) has an essential singularity at $z=1$ ( )

5. Rotation of a point (0, 1) using the matrix

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

about the origin through an angle $\pi / 4$ results in a point

(a) $\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ ( )

(b) $\left(\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)$ ( )

(c) (1, 0) ( )

(d) (0, −1) ( )

6. The rank of $n \times m$ matrix

(a) is the largest square submatrix with non-zero determinant ( )

(b) is the number of columns in $n \times m$ matrix ( )

(c) is the number of rows in $n \times m$ matrix ( )

(d) is the largest square submatrix with zero determinant ( )

7. In cylindrical coordinate system, the intersection between coordinate surfaces $\rho = c_1$ and $z = c_3$ is a/an

(a) straight line ( )

(b) circle ( )

(c) semi-circle ( )

(d) ellipse ( )

8. If x^i, $i = 1, 2$ represents rectangular coordinates, the relation $x^i x^i = 1$ would represent

(a) a circle of unit radius ( )

(b) a sphere of unit radius ( )

(c) a straight line in two dimensions ( )

(d) a hypersphere of unit radius ( )

9. The output of the program

```
for (char i='A'; i<'E'; i++)
        cout <<i;
```

will be

(a) A C ( )

(b) B C D ( )

(c) A B C D ( )

(d) A B C D E ( )

10. In C++ program given below, the value of x after the second statement is

```
int x = 3; // first
x+ =10; // second
```

(a) 13 ( )

(b) 10 ( )

(c) 16 ( )

(d) 0 ( )

SECTION—II

(*Marks* : 15)

Give short answers to the following questions : 3×5=15

1. Show that $\beta(m, n) = \beta(n, m)$

2. Show that the function $f(z) = u + iv$ with $u = x^2 - y^2$, $v = 2xy$ satisfy Cauchy-Riemann equation.

3. Show that every square matrix can be uniquely expressed as the sum of symmetric and skew-symmetric matrices.

4. Show that the tangent unit vectors are identical to perpendicular unit vectors in orthogonal curvilinear coordinate system.

5. What are structure and string in C++ programming language?

★★★

V/PHY (vi) (PR)

2016

(5th Semester)

PHYSICS

SIXTH PAPER

(Quantum Mechanics—II)

(Pre-Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. Explain what you mean by 'matter waves'. Describe with neat diagrams, the experiments of Davisson and Germer on the diffraction of electrons. How does it establish the wave nature of matter? 10

Or

(a) Show that de Broglie wavelength for a material particle of rest mass m_0 and charge q, accelerated from rest through a potential difference of V volts relativistically is given by

$$\frac{h}{\sqrt{2m_0qV\ 1\ \frac{qV}{2m_0c^2}}}$$ 5

(b) What do you mean by quantum numbers? Write down the possible quantum numbers for n 2. 2

(c) Explain why material particle can only be represented by a group wave, not by a single wave. 3

2. *(a)* What are linear vector space and Hilbert space? 3

(b) Consider three elements from the vector space of real 2 2 matrices

$$|1\ \begin{matrix}0 & 1\\ 0 & 0\end{matrix},\ |2\ \begin{matrix}1 & 1\\ 0 & 1\end{matrix}\ \text{and}\ |3\ \begin{matrix}2 & 1\\ 0 & 2\end{matrix}$$

Show whether they are linearly dependent or not. 3

(c) Use Gram-Schmidt procedure to orthonormalize the basis

$$|1\rangle = \begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix}, |2\rangle = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}, |3\rangle = \begin{pmatrix} 0 \\ 2 \\ 5 \end{pmatrix} \quad 4$$

Or

(a) Show that two eigenfunctions of a Hermitian operator belonging to two distinct eigenvalues are orthogonal. 5

(b) Show that if two Hermitian operators commute, their product is also Hermitian. 5

3. Derive time-dependent form of Schrödinger equation. Give a physical interpretation of wave function. Explain the normalization of wave function. 5+2+3=10

Or

State Ehrenfest's theorem. Use this theorem to show that classical mechanics agrees with quantum mechanics so far as expectation values are concerned. 2+8=10

4. What do you mean by quantum mechanical tunnelling effect? Show that the transmittance of a particle incident at rectangular potential barrier is given by

$$T \quad \frac{16E(V_0 \quad E)}{V_0^2} \exp \quad \frac{2\sqrt{2m(V_0 \quad E)}}{h} a$$

where V_0 is the potential barrier, a is barrier thickness. 10

Or

What is zero-point energy of harmonic oscillator? Derive the expression for the eigenfunction in terms of Hermite polynomials of a linear harmonic oscillator. 2+8=10

5. *(a)* Show that commutation relation between X and Y components of angular momentum L_x and L_y is given by

$$[L_x, L_y] \quad i\hbar L_z \quad 5$$

(b) What do you mean by orbital gyromagnetic ratio for an electron? Obtain an expression for it. 1+4=5

Or

State Uhlenbeck and Goudsmit's hypothesis of electron spin. What are Pauli spin operators? Express Pauli spin functions in the form of 2 2 matrices. Write down the commutation relation satisfied by the three components. 1+3+3+3=10

★ ★ ★

Subject Code : V/ PHY (vi) (PR)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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 1 (one) Hour 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)*

2016

(5th Semester)

PHYSICS

SIXTH PAPER

(Quantum Mechanics—II)

(Pre-Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

1. The ground state energy of hydrogen atom is

(a) – 16·3 eV ( )

(b) – 13·6 eV ( )

(c) – 1·36 eV ( )

(d) – 64·1 eV ( )

2. According to Schrödinger, a particle is equivalent to

(a) a single wave ( )

(b) a wave packet ( )

(c) a light wave ( )

(d) Both *(a)* and *(c)* ( )

3. Two kets $|a\rangle$ and $|b\rangle$ are orthonormal, if

(a) $\langle b|b\rangle = 0, \langle a|b\rangle = 0, \langle a|a\rangle = 1$ ( )

(b) $\langle a|b\rangle = 1, \langle a|a\rangle = 1, \langle b|b\rangle = 1$ ( )

(c) $\langle a|b\rangle = 0, \langle b|b\rangle = 1, \langle a|a\rangle = 1$ ( )

(d) $\langle a|b\rangle = 1, \langle b|b\rangle = 1, \langle a|a\rangle = 0$ ( )

4. Eigenvalues of Hermitian operators

(a) are real only ( )

(b) are imaginary only ( )

(c) can be real or imaginary ( )

(d) are always complex ( )

5. Let ψ be a wave function, the quantity $\psi * \psi$ represents

(a) probability density ( )

(b) charge density ( )

(c) energy density ( )

(d) wave density ( )

6. In the equation $F\psi = f\psi$, the eigenfunction of the equation is

(a) F ( )

(b) $f\psi$ ( )

(c) f ( )

(d) ψ ( )

7. For a particle confined in a box, the eigenfunction ψ_n is given by

(a) $\psi_n = A\sin\left(\frac{\pi x}{4an}\right)$ ( )

(b) $\psi_n = A\cos\left(\frac{n\pi x}{3a}\right)$ ( )

(c) $\psi_n = A\sin\left(\frac{n\pi x}{2a}\right)$ ( )

(d) $\psi_n = \sin\left(\frac{n\pi x}{3a}\right)$ ( )

8. For a free particle in step potential, let R and T be reflectance and transmittance, then

(a) $R+T=1$ ( )

(b) $R=T$ ( )

(c) $R-T=1$ ( )

(d) $R\cdot T=1$ ( )

9. For the angular momentum operators L_x and L_y, the operator L_+ can be defined as

(a) $L_+ = L_x + iL_y$ ( )

(b) $L_+ = L_x - iL_y$ ( )

(c) $L_+ = L_y + iL_x$ ( )

(d) $L_+ = L_y - iL_x$ ( )

10. For electron, the number of possible spin states for Z component is

(a) 1 ( )

(b) 2 ( )

(c) 3 ( )

(d) 4 ( )

SECTION—II

(*Marks* : 15)

Give short answers to the following questions : 3×5=15

1. A charge particle accelerated by 200 V has a de Broglie wavelength 0·20 Å. Find the mass of the particle.

2. What is an expectation value of position and momentum operator in quantum mechanics?

3. What are the basic postulates of quantum mechanics?

4. The potential energy of a simple harmonic oscillator of mass m and oscillating with an angular frequency ω is $V(x) = \frac{1}{2} m\omega^2 x^2$. Write down the Hamiltonian operator and Schrödinger equation for the oscillator.

5. Show that electron spin magnetic moment is equal to Bohr magneton.

★★★

V/PHY (vi) (R)

2016

(5th Semester)

PHYSICS

SIXTH PAPER

(Quantum Mechanics—II)

(Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. What is de Broglie hypothesis? Describe Davisson-Germer experiment for the study of electron diffraction. What are the results of the experiment? 2+8=10

Or

(a) Obtain Schrödinger time-independent equation. Write the equation in eigenvalue equation form. 6

(b) Write four basic postulates of quantum mechanics. 4

2. A beam of particles of mass m and energy E is incident from the left on a rectangular potential barrier of the form

$$V(x) \quad \begin{matrix} 0 , & x & 0 \\ V_0 , & 0 & x & a \\ 0 , & x & a \end{matrix}$$

where V_0 is the height and a is the thickness of the potential barrier. Discuss the solution for E V_0 and explain how tunnelling can be understood without violation of energy. Give two examples of quantum tunnelling. 9+1=10

Or

(a) What do you mean by operator in quantum mechanics? What is a linear operator? The operator $x \frac{d}{dx}$ has the eigenvalue . Obtain its eigenfunction. 1+1+2=4

(b) What do you mean by eigenvalues and eigenvectors of an operator? For a Hermitian operator, show that the eigenvectors corresponding to different eigenvalues are orthogonal. 2+4=6

3. What is zero point energy of harmonic oscillator? Derive the expression for the eigenfunction in terms of Hermite polynomials of a linear harmonic oscillator. 2+8=10

Or

Solve the radial equation

$$\frac{1}{r^2}\frac{}{r}\,r^2\frac{R}{r}\quad\frac{2mE}{\hbar^2}\quad\frac{2mV(r)}{\hbar^2}\quad\frac{l(l\quad 1)}{r^2}\,R\quad 0$$

of the hydrogen atom, where the symbols have their usual meanings. Show that the energy values are exactly the same as those obtained by Bohr. 9+1=10

4. *(a)* Describe Gram-Schmidt ortho-normalization process. Apply this process for a doubly degenerate system. 4+2=6

(b) Consider three elements from the vector space of real 2 2 matrices :

$$|1\quad\begin{matrix}0 & 1\\ 0 & 0\end{matrix},\quad |2\quad\begin{matrix}1 & 1\\ 0 & 1\end{matrix}$$

$$|3\quad\begin{matrix}2 & 1\\ 0 & 2\end{matrix}$$

Show whether they are linearly dependent or not. 4

Or

(a) Define the basis and dimensions of a vector space. 2

(b) Consider the following two kets :

$$|\quad\begin{matrix}5i\\ 2\\ i\end{matrix}\quad\text{and}\quad|\quad\begin{matrix}3\\ 8i\\ 9i\end{matrix}$$

(i) Find | and |.

(ii) Is | normalized? If not, normalize it.

(iii) Are | and | orthogonal? 1+2+1=4

(c) Consider the state

$$|\quad 3i\,|\,\upsilon_1\quad 7i\,|\,\upsilon_2$$

$$|\quad\ |\,\upsilon_1\quad 2i\,|\,\upsilon_2$$

where $|\upsilon_1$ and $|\upsilon_2$ are orthonormal.

(i) Calculate | and |.

(ii) Show that | | . 2+2=4

5. *(a)* Calculate Bohr magneton for an electron moving in an elliptical orbit of an area A and time period T. 4

(b) Describe Stern-Gerlach experiment. 6

Or

(a) Using the eigenstates

$$\left|\frac{1}{2}, \frac{1}{2}\right\rangle \text{ and } \left\langle\frac{1}{2}, \frac{1}{2}\right|$$

as basis vectors, obtain the Pauli spin matrices. Hence, prove the commutation relation

$$[\ _i,\ \ _j]\ \ 2i\ _{ijk}\ \ _k$$

where

$_{ijk}$ 1 , *ijk* have cyclic permutation
1 , *ijk* have anticyclic permutation
0 , otherwise

6+2=8

(b) A particle with spin $\frac{1}{2}$ is in the state $\frac{1}{\sqrt{6}}\ \ ^{1}_{2}\ \ ^{i}$, if we measure S_z. What are the probabilities of getting $\frac{h}{2}$ and $\frac{h}{2}$? 2

★ ★ ★

Subject Code : V/ PHY (vi) (R)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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 1 (one) Hour 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)*

2016

(5th Semester)

PHYSICS

SIXTH PAPER

(Quantum Mechanics—II)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

1. The calculated value of the wavelength of electron using de Broglie's formula is

(a) 0·661 nm ( )

(b) 0·166 nm ( )

(c) 0·616 nm ( )

(d) 1·66 nm ( )

2. For non-dispersive medium, group velocity and phase velocity are related by the equation

(a) $v_g < v_p$ ( )

(b) $v_g = v_p$ ( )

(c) $v_g > v_p$ ( )

(d) $\frac{v_g}{v_p} = 0$ ( )

3. The eigenvalue of the particle inside a box is given by the relation

(a) $E_n = \frac{nh}{8mL^2}$ ( )

(b) $E_n = \frac{n^2h}{8m^2L}$ ( )

(c) $E_n = \frac{n^2h^2}{8mL^2}$ ( )

(d) $E_n = \frac{n^2h^2}{8m^2L^2}$ ( )

4. The potential function of a potential step is defined by

(a) $V(x) = 0 \quad , \quad x < 0$

$= V_0 \, , \quad x > 0$ ( )

(b) $V(x) = 0 \quad , \quad x > 0$

$= V_0 \, , \quad x < 0$ ( )

(c) $V(x) = V_0 \, , \quad x < 0$

$= 0 \quad , \quad x = \infty$ ( )

(d) $V(x) = 1 \quad , \quad x < 0$

$= \infty \quad , \quad x > 0$ ( )

5. The energy of a harmonic oscillator is quantized in steps of

(a) $h^2\nu^2$ ( )

(b) h / ν ( )

(c) $\frac{ch}{\nu}$ ( )

(d) $h\nu$ ( )

6. The solution of the azimuthal wave equation

$$\frac{d^2\psi_3}{d\phi^2} + m_l^2\,\psi_3 = 0$$

is

(a) $\psi_3(\phi) = A\exp(im_l\,\phi)$ ( )

(b) $\psi_3(\phi) = A^2\exp(im_l\,\phi)$ ( )

(c) $\psi_3(\phi) = A\exp(im_l\,\phi + 2\pi)$ ( )

(d) $\psi_3(\phi) = A\exp\left(im_l\,\phi + \frac{2}{3}\pi\right)$ ( )

7. The angular momentum operator is defined as

(a) $L = -\frac{\vec{r}\times\vec{\nabla}}{i\hbar}$ ( )

(b) $L = -i\hbar\vec{r}\times\vec{\nabla}^2$ ( )

(c) $L = -i\hbar\vec{r}\times\vec{\nabla}$ ( )

(d) $L = -\frac{i\hbar}{\vec{r}\times\vec{\nabla}}$ ( )

8. The smallest unit of magnetic dipole moment is

(a) Bohr radius ( )

(b) Landé's splitting factor ( )

(c) farad ( )

(d) Bohr electron magneton ( )

9. The eigenvalues of Hermitian operator are

(a) not real ( )

(b) real ( )

(c) zero ( )

(d) infinite ( )

10. The scalar product of two vectors $|\psi_1\rangle$ and $|\psi_2\rangle$ is defined by

(a) $\langle\psi_1|\psi_2\rangle = \int_{-\infty}^{\infty} \psi_1^*(x)\,\psi_2^*(x)\,dx$ ( )

(b) $\langle\psi_1|\psi_2\rangle = \int_{-\infty}^{\infty} \psi_2^*(x)\,\psi_1^*(x)\,dx$ ( )

(c) $\langle\psi_1|\psi_2\rangle = \int_{-\infty}^{\infty} \frac{\psi_2^*(x)}{\psi_1^*(x)}\,dx$ ( )

(d) $\langle\psi_1|\psi_2\rangle = \int_{-\infty}^{\infty} \frac{\psi_1^*(x)}{\psi_2^*(x)}\,dx$ ( )

SECTION—II

(*Marks* : 15)

Give short answers to the following questions : 3×5=15

1. What is expectation value of an operator? Obtain the expectation value for energy and momentum.

2. Give the physical interpretation of wave function. What does normalization condition mean?

3. What are the three quantum numbers associated with wave functions of a hydrogen atom? Give their significance.

4. What are linear vector space and Hilbert space?

5. Show that $[L_z, L^2]$ is equal to zero, where L is angular momentum operator.

★★★

V/ PHY (vii) (PR)

2016

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

Full Marks : 55

Time : 2½ hours

(Pre-Revised)

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* What are Kepler's laws of planetary motion? 2

(b) Deduce Kepler's laws of planetary motion from Newton's law. 5

Or

(a) Using Lagrangian formulation, obtain the equation of motion of a simple pendulum and hence deduce the formula for its time period for small amplitude oscillations. 5

(b) Show that for equilibrium of a system, the virtual work of applied forces is zero. 2

2. What is Brownian motion? Discuss Einstein's theory of translational Brownian motion. 1+6=7

Or

(a) What is meant by 'mean free path' of a molecule of a gas? Derive an expression for mean free path. 1+4=5

(b) Discuss the law of distribution of free path. 2

3. *(a)* Using Maxwell's thermodynamic relations, deduce (C_p C_v) relations for perfect and real gases. 5

(b) Using Maxwell's relations, derive the first $T\ dS$ equation. 2

Or

(a) What do you understand by the transport phenomena of gases? 2

(b) Derive an expression for the coefficient of thermal conductivity. 5

4. *(a)* Explain the term 'phase space'. 2

(b) Calculate the number of phase cells in the energy range O to E for a linear simple harmonic oscillator of mass m and frequency . 5

Or

Derive the condition of equilibrium between two systems in thermal contact and explain how it links with macroscopic physics. 7

5. *(a)* Using MB statistics, derive an expression for total internal energy and specific heat at constant volume of an ideal gas. 5

(b) Discuss Bose-Einstein statistics. 2

Or

'In quantum statistics, h is selected as a constant by nature', explain by using the case of particle in one-dimensional box. 7

★ ★ ★

Subject Code : V/PHY (vii) (PR)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2016

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

(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. A rigid body moving freely in space has degree of freedom

(a) 3 ( )

(b) 6 ( )

(c) 9 ( )

(d) 4 ( )

2. The kinetic energy per unit volume of a perfect gas is equal to

(a) $\frac{2}{3}P$ ( )

(b) $\frac{3}{2}P$ ( )

(c) $\frac{P}{3}$ ( )

(d) $\frac{1}{2}P$ ( )

where P is pressure.

3. The variation of C_V with volume is zero for

(a) real gas ( )

(b) ideal gas ( )

(c) both real and ideal gases ( )

(d) None of the above ( )

4. The value of probability of an event cannot be

(a) zero ( )

(b) 1 ( )

(c) $\frac{1}{2}$ ( )

(d) negative ( )

5. The particles obeying Maxwell-Boltzmann statistics are

(a) identical ( )

(b) identical and indistinguishable ( )

(c) distinguishable ( )

(d) photons ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. State and prove d'Alembert's principle.

2. Deduce the average velocity of a gas molecule.

3. What do you mean by triple point?

4. Explain the principles of equal and a priori probabilities.

5. Explain Fermi-Dirac statistics.

★★★

V/PHY (vii) (R)

2016

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

Full Marks : 55

Time : 2½ hours

(Revised)

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Deduce Hamilton's canonical equations from Lagrangian equation. 3

(b) Using Hamilton's formulation, derive the equation of motion for a simple pendulum. 4

Or

(a) Show the equation of the orbit in a central force is given by

$$\frac{d^2u}{d^{\ 2}} \quad u \qquad \frac{m}{J^2u^2}F \quad \frac{1}{u}$$ 4

(b) Deduce Newton's law of gravitation from Kepler's law of planetary motion. 3

2. Write down the Maxwell's law of distribution of molecular speeds in an ideal gas and obtain the expressions for *(a)* average or mean speed and *(b)* root mean square speed. 1+3+3=7

Or

Describe how Perrin verified Einstein theory of Brownian motion experimentally and led him to determine Avogadro's number (N). 7

3. What is transport phenomena in gases? Give an elementary theory of self-diffusion and hence show that the coefficient of diffusion is directly proportional to the cube of the square root of absolute temperature and inversely proportional to the pressure. 1+6=7

Or

What do you mean by 'thermodynamic potentials or functions'? Derive any three Maxwell's thermodynamic relations from thermodynamic potentials or thermodynamical energy functions. 1+6=7

4. State and prove Boltzmann canonical distribution theorem. 1+6=7

Or

(a) Deduce the relation $S \quad k \ln \quad W$, where S entropy and W thermodynamic probability. 4

(b) Compare canonical, micro-canonical and grand canonical ensembles. 3

5. Explain Fermi energy and Fermi level. Using F-D statistics, determine the Fermi energy of an electron gas in a metal. 3+4=7

Or

(a) Apply M-B energy distribution law to find internal energy and specific heat at constant volume of an ideal gas. 5

(b) What are bosons and fermions? 2

★ ★ ★

Subject Code : V/PHY (vii) (R)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2 0 1 6

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Thermal Physics)

(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. Hamiltonian equations of motion are given by

(a) $\dot{q} = -\frac{\partial H}{\partial p}, \ \dot{p} = \frac{\partial H}{\partial q}$ ( )

(b) $\dot{q} = -\frac{\partial H}{\partial q}, \ \dot{p} = \frac{\partial H}{\partial p}$ ( )

(c) $\dot{q} = -\frac{\partial H}{\partial q}, \ \dot{p} = -\frac{\partial H}{\partial p}$ ( )

(d) $\dot{q} = \frac{\partial H}{\partial p}, \ \dot{p} = -\frac{\partial H}{\partial q}$ ( )

2. The mean free path of gas molecules varies with temperature (T) and pressure (P) as

(a) $T^{-1}P^{-1}$ ( )

(b) TP ( )

(c) TP^{-1} ( )

(d) $T^{-1}P$ ( )

3. If c, $\bar{c}$, c_P represent the r.m.s. speed, average speed and most probable speed of gas molecules at a given temperature, then

(a) $c = \bar{c} = c_P$ ( )

(b) $c > \bar{c} > c_P$ ( )

(c) $\bar{c} > c > c_P$ ( )

(d) $c > c_P > \bar{c}$ ( )

4. An ensemble is a collection of all possible

(a) macroscopically identical, but independent thermodynamic systems ( )

(b) macroscopic of a given system ( )

(c) microstates of a given system ( )

(d) microstates of a given macrostate ( )

5. Which of the following particles do not obey B-E statistics?

(a) Photons ( )

(b) Protons ( )

(c) Pions ( )

(d) Gas molecules ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. What are constraints? How are they classified?

2. Define collision probability. Find a relation between collision probability and mean free path of gas molecules.

3. Prove the thermodynamic relation

$$TdS = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dV$$

where the symbols have their usual meanings.

4. State and explain the term 'thermodynamic probability'.

5. Compare Bose-Einstein and Maxwell-Boltzmann statistics.

★★★

V/ PHY (viii) (A) (PR)

2016

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Spectroscopy)

(Pre-Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Derive the formula for Rutherford's scattering cross-section, and discuss the drawback of the Rutherford's model of the atom. 4+3=7

Or

Discuss the principle and the experimental arrangement of Stern-Gerlach experiment, and explain its significance. 5+2=7

2. State and explain Pauli's exclusion principle. On the basis of this principle, how do you calculate the number of electrons that can occupy in a sub-shell inside an atom? 1+2+4=7

Or

What is Zeeman effect? Give the classical interpretation of normal Zeeman effect, and derive the expression for Zeeman shift. 2+3+2=7

3. What is Einstein's coefficient in LASER system? Hence derive the necessary equations to express the Einstein's *A* and *B* coefficients. 1+6=7

Or

With necessary diagram, explain the construction and working of any *one* of the following : 7

(a) He-Ne LASER

(b) Semiconductor LASER

4. With necessary diagram, obtain an expression for the energy level, frequency of spectral line and the selection rule in a rigid diatomic rotator. 3+3+1=7

Or

Calculate the moment of inertia and inter-nuclear distance of HCl molecule by approximating it as a rigid rotator if the

radiation associated with the transition $j = 3$ to $j = 4$ is $83{\cdot}03\ \text{cm}^{-1}$. 5+2=7

Given,

$h = 6{\cdot}62 \times 10^{-27}$ erg sec

$c = 3 \times 10^{10}$ cm sec^{-1}

5. Explain the sequence and progression in electronic spectra, and hence derive the frequency of the spectrum due to a change in total energy of the molecule. 7

Or

(a) Define the *P*, *Q* and *R* branches in the spectrum of rotational fine structure in electronic vibrational transition. 4

(b) What is Fortrat diagram? Mention the information observed in the Fortrat diagram. 2+1=3

★★★

Subject Code :

V/ PHY (viii) (A) (PR)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2 0 1 6

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Spectroscopy)

(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. According to Bohr's postulate, an electron of mass m moving in a circular path of radius r with velocity v will satisfy the relation

(a) $\frac{mv}{r} = \frac{nh}{2\pi}$ ( )

(b) $\frac{mv}{r} = \frac{2\pi}{nh}$ ( )

(c) $mvr = \frac{2\pi}{nh}$ ( )

(d) $mvr = \frac{nh}{2\pi}$ ( )

where $n = 1, 2, 3, \ldots$ is called the principal quantum number.

2. The Auger effect is also called

(a) radiationless transition ( )

(b) positron transition ( )

(c) radiation transition ( )

(d) electron transition ( )

3. A LASER action is based on the amplification of

(a) atomic vibration ( )

(b) electromagnetic vibration ( )

(c) molecular interaction ( )

(d) electromagnetic oscillation ( )

4. The zero-point energy of a vibrating diatomic molecule is

(a) $\frac{1}{4} h\omega_{os}$ joule ( )

(b) $\frac{1}{2} h\omega_{os}$ joule ( )

(c) $h\omega_{os}$ joule ( )

(d) $2h\omega_{os}$ joule ( )

here, ω_{os} is oscillating frequency.

5. Raman spectra is appeared due to the scattering of radiation by the

(a) dipole moment of molecules ( )

(b) rotating molecules ( )

(c) vibrating molecules ( )

(d) absorption of molecules ( )

SECTION—II

(*Marks* : 15)

Give very short answers of the following questions : 3×5=15

1. The wavelength of the Balmer series in hydrogen is 3646 Å. Calculate Rydberg constant in cm^{-1}.

2. What is Paschen-Back effect?

3. Explain the population inversion in LASER action.

4. Explain the general idea of Born-Oppenheimer approximation.

5. What do you understand by band origin and band head in the rotational fine structure of electronic vibration spectra of the molecule?

★★★

V/ PHY (viii) (A) (R)

2016

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Revised)

(Spectroscopy)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Deduce the Rutherford's formula for the scattering of alpha particles by a nucleus of charge Ze. "Rutherford's model of atoms failed to account for the stability of the atoms." Comment. 6+1=7

Or

Explain the Sommerfeld's relativistic correction and fine structure of spectral lines of hydrogen-like atoms. Give the selection rule. 6+1=7

2. What do you mean by vector model of atoms? Give the physical significances of various quantum numbers n, l, s, j, m_l and m_s. 1+6=7

Or

(a) What do you mean by Larmor's precession? Obtain an expression for Larmor's frequency.

(b) The ground state of chlorine is $^2P_{3/2}$. Find the value of Lande's splitting factor (g). In how many substates will the ground state split in a weak magnetic field? 1+4+1+1=7

3. What is Zeeman effect? Give the classical theory of normal Zeeman effect. Use this theory to determine the value of the specific charge (e/m) of electron. 1+5+1=7

Or

What do you mean by Einstein's A and B coefficients? Derive a relation between them. 2+5=7

4. Write down the expression for the allowed energy levels of a rotating diatomic molecule treated as a rigid rotator. Deduce its frequency of spectral lines. Discuss its spectrum and relevant selection rule. 1+2+3+1=7

Or

Write down the expression for the allowed energy levels of a vibrating diatomic molecule treated as a harmonic oscillator. Deduce its frequency of spectral lines. Discuss its spectrum and relevant selection rule. 1+2+3+1=7

5. *(a)* What is Raman effect? Explain it using quantum mechanics.

(b) With exciting line 2536 Å a Raman line for a sample is observed at 2612 Å. Calculate the Raman shift in cm^{-1} units.

1+4+2=7

Or

Write short notes on : 3½+3½=7

(a) Sequence and progression in electronic band system

(b) Fortrat diagram

★★★

Subject Code : V/ PHY (viii) (A) (R)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2 0 1 6

(5th Semester)

PHYSICS

EIGHTH (A) PAPER

(Revised)

(Spectroscopy)

(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. In Rutherford's alpha particle scattering experiment, the number of alpha particles scattered at an angle 90° is 25. How many alpha particles are scattered at an angle 60°?

(a) 85 ( )

(b) 100 ( )

(c) 70 ( )

(d) 55 ( )

2. The maximum number of electrons in a sub-shell is

(a) $2n^2$ ( )

(b) $(2l-1)$ ( )

(c) $(2l+1)$ ( )

(d) $2(2l+1)$ ( )

where n is the principal quantum number and l is the orbital quantum number.

3. The splitting of spectral lines under the influence of an external electric field is called

(a) Zeeman effect ( )

(b) Faraday effect ( )

(c) Stark effect ( )

(d) Paschen-Back effect ( )

4. The change of energy of molecules which does not produce any spectral line is the change in

(a) translational kinetic energy ( )

(b) vibrational kinetic energy ( )

(c) rotational kinetic energy ( )

(d) electronic energy ( )

5. In a vibrational-rotational molecular band

(a) rotational transitions $\Delta J = +1$ produce *R*-branch ( )

(b) rotational transitions $\Delta J = +1$ produce *P*-branch ( )

(c) rotational transitions $\Delta J = -1$ produce *R*-branch ( )

(d) rotational transitions $\Delta J = -1$ produce *Q*-branch ( )

SECTION—II

(*Marks* : 15)

Give short answers of the following questions : 3×5=15

1. A hydrogen atom is in the ground state. What is the value of the principal quantum number to which it will be excited by absorbing a photon of energy 12·75 eV?

2. Explain space quantization with suitable diagram.

3. Explain 'Auger effect'.

4. Give the applications of vibrational spectroscopy.

5. Differentiate between Raman spectra and infrared spectra.

★★★

V/ PHY (viii) (B) (PR)

2016

(5th Semester)

PHYSICS

EIGHTH (B) PAPER

(C Language and Numerical Methods)

(Pre-Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* What are identifiers and keywords in C programs? Give examples. 3½

(b) Write down the structure and format of C programs. 3½

Or

(a) What are integer and floating point data types? How are they declared in C programs? 3

(b) If in a C program, a and b are declared as integer data type and c and d are declared as floating point data type, find out which of the following arithmetic statements are wrong and give reasons : 2

(i) $c = a / b$

(ii) $b + 5 \cdot 0$

(iii) $a / b * \% b$

(iv) $a \cdot b$

(c) What is declaration statement in C? Give its format. 2

2. What are the formatted and unformatted input/output functions in C programs? Show how they are used and expressed in C programs with examples. 3+4=7

Or

(a) What are library functions and user-defined functions in C programs? What are their benefits of using them? How are these functions declared in C programs? 3+1+1=5

(b) Write a simple C program to find the circumference and area of a circle. 2

3. What is structure in C programs? Discuss how it is used in C programs and explain its applications with example. 1+3+3=7

Or

What is an array in C programs? Write a simple C program using array to calculate average marks of 20 students. 2+5=7

4. What do you mean by interpolation? Use the Lagrange and the Newton divided difference formulas to calculate $f(3)$ from the following table : 1+3+3=7

x	0	1	2	4	5	6
$f(x)$	1	14	15	5	6	19

Or

Explain Newton-Raphson iterative method using illustrative figure. Find the three roots of the equation $x^3 - 4x + 1 = 0$ to 3 significant digits using Newton-Raphson method. 3+4=7

5. Explain Simpson's 1/3rd rule for numerical integration. Evaluate $\int_0^6 \frac{dx}{1+x^2}$ by using Simpson's 1/3rd rule. 3+4=7

Or

(a) State the first and second De Morgan's theorem. Also provide the equivalent logic circuits. 2+2=4

(b) Reduce the following Boolean functions : 1½+1½=3

(i) $A + \bar{A}B + AB$

(ii) $A\bar{B} + \bar{A}B + AB + \bar{A}\bar{B}$

★★★

Subject Code :

V/ PHY (viii) (B) (PR)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2016

(5th Semester)

PHYSICS

EIGHTH (B) PAPER

(C Language and Numerical Methods)

(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. Which of the following correctly shows the hierarchy of arithmetic operations in C?

(a) / + * − ( )

(b) * − / + ( )

(c) + − / * ( )

(d) / * + − ( )

2. Which one of the following is the only function all C programs must contain?

(a) start() ( )

(b) system() ( )

(c) main() ( )

(d) printf() ( )

3. In the given statement below, what does the 'pf' indicate?

Int (*pf)();

(a) pf is a pointer of a function which returns int ( )

(b) pf is a pointer ( )

(c) pf is a function pointer ( )

(d) pf is an array ( )

4. The number of significant digits in the number 204.020050 is

(a) 5 ( )

(b) 6 ( )

(c) 8 ( )

(d) 9 ( )

5. The decimal number equivalent of hexadecimal number ED2 is

(a) 2700 ( )

(b) 3794 ( )

(c) 232 ( )

(d) 353 ( )

SECTION—II

(*Marks* : 15)

Give short answers of the following questions : 3×5=15

1. In a C program statement given below, what will be the value of x ?

$$x = 2 + 4 * 2 / 8 \% 2 - 1$$

2. Using printf and scanf, write a simple C program to enter two integers and print their sum.

3. What are pointers in C programs? How are they declared?

4. What are absolute and relative errors? Give examples.

5. Explain trapezoidal rule for numerical integration.

★★★

V/ PHY (viii) (B) (R)

2016

(5th Semester)

PHYSICS

EIGHTH (B) PAPER

(C Language and Numerical Methods)

(Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* What are identifiers and keywords in C programs? Give examples. 3½

(b) Write down the structure and format of C programs. 3½

Or

(a) What are integer and floating-point data types? How are they declared in C programs? 3

(b) If in a C program, a and b are declared as integer data type and c and d are declared as floating-point data type, find out which of the following arithmetic statements are wrong and give reasons : 2

(i) $c = a / b$

(ii) $b + 5 \cdot 0$

(iii) $a / b * \% b$

(iv) $a \cdot b$

(c) What is declaration statement in C? Give its format. 2

2. What are the formatted and unformatted input/output functions in C programs? Show how they are used and expressed in C programs with examples. 3+4=7

Or

(a) What are library functions and user-defined functions in C programs? What are the benefits of using them? How are these functions declared in C programs? 3+1+1=5

(b) Write a simple C program to find the circumference and area of a circle. 2

3. What are the major decision-making statements in C? Define those with examples and illustrative flowchart. 2+3+2=7

Or

What is an array in C programs? Write a simple C program using array to calculate average marks of 20 students. 2+5=7

4. What do you mean by interpolation? Use the Lagrange and the Newton divided difference formulas to calculate $f(3)$ from the following table : 1+3+3=7

x	0	1	2	4	5	6
$f(x)$	1	14	15	5	6	19

Or

Explain Newton-Raphson iterative method using illustrative figure. Find the three roots of the equation $x^3 - 4x + 1 = 0$ to 3 significant digits using Newton-Raphson method. 3+4=7

5. Explain Simpson's 1/3rd rule for numerical integration. Evaluate $\int_0^6 \frac{dx}{1+x^2}$ by using Simpson's 1/3rd rule. 3+4=7

Or

(a) State the first and second De Morgan's theorems. Also provide the equivalent logic circuits. 2+2=4

(b) Reduce the following Boolean functions : 1½+1½=3

(i) $A + \bar{A}B + AB$

(ii) $A\bar{B} + \bar{A}B + AB + \bar{A}\bar{B}$

★★★

Subject Code :

V/ PHY (viii) (B) (R)

Booklet No. A

Date Stamp .....

.....

To be filled in by the Candidate

DEGREE 5th Semester
(Arts / Science / Commerce / .....) Exam., **2016**

Subject .....
Paper .....

To be filled in by the Candidate

DEGREE 5th 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)*

2016

(5th Semester)

PHYSICS

EIGHTH (B) PAPER

(C Language and Numerical Methods)

(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. Which of the following correctly shows the hierarchy of arithmetic operations in C?

(a) / + * − ( )

(b) * − / + ( )

(c) + − / * ( )

(d) / * + − ( )

2. Which one of the following is the only function all C programs must contain?

(a) start() ( )

(b) system() ( )

(c) main() ( )

(d) printf() ( )

3. In the given statement below, what does the "pf" indicate?

Int (*pf)();

(a) pf is a pointer of a function which returns int ( )

(b) pf is a pointer ( )

(c) pf is a function pointer ( )

(d) pf is an array ( )

4. The number of significant digits in the number 204.020050 is

(a) 5 ( )

(b) 6 ( )

(c) 8 ( )

(d) 9 ( )

5. The decimal equivalent of hexadecimal number ED2 is

(a) 2700 ( )

(b) 3794 ( )

(c) 232 ( )

(d) 353 ( )

SECTION—II

(*Marks* : 15)

Give short answers to the following questions : 3×5=15

1. In a C program statement given below, what will be the value of x ?

$$x = 2 + 4 * 2 / 8 \% 2 - 1$$

2. Using printf and scanf, write a simple C program to enter two integers and print their sum.

3. What are pointers in C programs? How are they declared?

4. What are absolute and relative errors? Give examples.

5. Explain trapezoidal rule for numerical integration.

★★★