Sr. No. 100771 Roll No.

M.SC. (PHYSICS) - 1ST SEMESTER EXAMINATIONS; DEC.-2017

(SUBJECT: MATHEMATICAL PHYSICS; PAPER CODE – 09020101)

Time: 03:00 Hrs. **Max Mark: 60**

Instructions:

1. Write your Roll No. on the Question Paper.
2. Candidate should ensure that they have been provided with the correct question paper. Complaints in this regards, if any, should be made within 15 minutes of the commencement of the exam. No complaint(s) will be entertained thereafter.
3. Each Part is Compulsory. Marks are indicated against each question.
4. Draw the diagram wherever required.

PART-A (OBJECTIVE TYPE QUESTIONS OMR SHEETS)

ATTEMPT ALL QUESTIONS:-

Q. 1. If C is the contour defined by $|z|=\frac{1}{2}$, the value of the integral $\oint \frac{dz}{\sin^2 z}$ is:- **(1)**

a) ∞ **b)** $2\pi i$ **c)** 0 **d)** πi

Q. 2. Which of the following functions is the real part of a complex analytic function $z = x + iy$?:- **(1)**

a) $2x^2y$ **b)** x^2-y^2 **c)** x^2y-y-y^3 **d)** x^3-y^2

Q. 3. A vector perpendicular to any vector that lies on the plane defined by $x+y+z=5$, is:- **(1)**

a) $\hat{i}+\hat{j}$ **b)** $\hat{j}+\hat{k}$ **c)** $\hat{i}+\hat{j}+\hat{k}$ **d)** $2\hat{i}+3\hat{j}+5\hat{k}$

Q. 4. The eigenvalues of the antisymmetric matrix $A=\begin{pmatrix} 0 & -n_3 & n_2 \\ n_3 & 0 & n_1 \\ -n_2 & n_1 & 0 \end{pmatrix}$, Where n_1, n_2 and n_3 are the components of a unit vector, are:- **(1)**

a) 0, i, -i **b)** 0, 1, -1 **c)** 0, 1+i, 1-i **d)** 0, 0, 0

Q. 5. The inverse Laplace transforms of $\frac{1}{s^2(s+1)}$ is:- **(1)**

a) $\frac{1}{2}t^2e^{-t}$ **b)** $\frac{1}{2}t^2+1-e^{-t}$ **c)** $t-1+e^{-t}$ **d)** $\frac{1}{2}t^2(1-e^{-t})$

Q. 6. . If A, and B C are non-zero Hermitian operators, which of the following relations must be false:- **(1)**

a) $[A,B]=C$ **b)** AB+BA=C **c)** ABC=C **d)** A+B=C

Q. 7. The value of integral $\int_{-\infty}^{\infty} \frac{dx}{1+x^4}$:- **(1)**

a) $\frac{\pi}{\sqrt{2}}$ **b)** $\frac{\pi}{2}$ **c)** $\sqrt{2}\pi$ **d)** 2π

Q. 8. Consider the differential equation $\frac{d^2x}{dt^2}-3\frac{dx}{dt}+2x=0$. If x = 0 at t =0 and x=1 at t=1, the value of x at t =2 is:- **(1)**

a) e^2+1 **b)** e^2+e **c)** e^2+2 **d)** 2e

Q. 9. The Laplace transform of $6t^3+3\sin 4t$ is:- (1)

a) $\frac{36}{s^4}+\frac{12}{s^2+16}$ b) $\frac{36}{s^4}+\frac{12}{s^2-16}$ c) $\frac{18}{s^4}+\frac{12}{s^2+16}$ d) $\frac{18}{s^4}+\frac{12}{s^2-16}$

Q. 10. $A^2-A=0$, where A is a 9×9 matrix. Then:- (1)

a) A must be a zero matrix
b) A is an identity matrix
c) rank of A is 1 or 0
d) A is diagonalizable

Q. 11. A is a unitary matrix. Then eigen value of A are:- (1)

a) 1, -1 b) 1, -i c) i, -i d) -1, i

Q. 12. Let a and b be two distinct three dimensional vectors. Then the component of b that is perpendicular to a is given by:- (1)

a) $\frac{\vec{a}\times(\vec{b}\times\vec{a})}{a^2}$ b) $\frac{\vec{b}\times(\vec{b}\times\vec{a})}{b^2}$ c) $\frac{(\vec{a}.\vec{b})b}{b^2}$ d) $\frac{(\vec{b}.\vec{a})\vec{a}}{a^2}$ +Capital

Q. 13. A vector perpendicular to any vector that lies on the plane defined by $x+y+z=5$, is:- (1)

a) $\hat{i}+\hat{j}$ b) $\hat{j}+\hat{k}$ c) $\hat{i}+\hat{j}+\hat{k}$ d) $2\hat{i}+3\hat{j}+5\hat{k}$

Q. 14. The solution of the differential equation $\frac{dx}{dt}=x^2$, with the initial condition $x(0)=1$ will blow up as t tends to:- (1)

a) 1 b) 2 c) ½ d) ∞

Q. 15. If A, and B C are non-zero Hermitian operators, which of the following relations must be false:- (1)

a) [A, B]= C b) AB + BA =C c) ABA = C d) A+B = C

Q. 16. Let I be the identity transformation of the finite dimensional vector space V, then the nullity of I is:- (1)

a) dimV b) 0 c) 1 d) dimV - 1

Q. 17. Let T be a linear operator on the vector space V and T be invariant under the subspace W of V. Then:- (1)

a) $T(W)\in W$ b) $W\in T(W)$ c) $T(W)=W$ d) None of these

Q. 18. If a square matrix of order 10 has exactly 5 distinct eigen values, then the degree of the minimal polynomial is:- (1)

a) at least 5 b) at most 5 c) always 5 d) exactly 10

Q. 19. M is a 2-square matrix of rank 1, then M is:- (1)

a) diagonalizable and non singular
b) diagonalizable and nilpotent
c) neither diagonalizable nor nilpotent
d) either diagonalizable or nilpotent

Q. 20. $A=\begin{pmatrix}0 & 1\\ 0 & 0\end{pmatrix}$ then:- (1)

a) A has zero image
b) all the eigen value of A are zero
c) A is idempotent
d) A is non-nilpotent

Q. 21. The sum of eigen values of $\begin{pmatrix}-1 & -2 & -1\\ -2 & 3 & 2\\ -1 & 2 & -3\end{pmatrix}$ is:- (1)

a) -3 b) -1 c) 3 d) 1

Q. 22. The matrix $\begin{pmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{pmatrix}$ where $a,b,c \in R$ 0 has:- **(1)**

a) three real, non-zero eigen values **b)** complex eigen values
c) two non-zero eigen values **d)** only one non-zero eigen value

Q. 23. Rank of $A_{7\times5}$ is 5 and that of $B_{5\times7}$ is 3, then rank of AB is:- **(1)**

a) 1 **b)** 2 **c)** 3 **d)** 4

Q. 24. Let A and B are square matrices such that AB I, then zero is an eigen value of:- **(1)**

a) A but not of B **b)** B but not of A **c)** both A and B **d)** neither A nor B

Q. 25. The eigen values of a skew-symmetric matrix are:- **(1)**

a) negative **b)** real
c) absolute value of 1 **d)** purely imaginary or zero

Q. 26. A is a unitary matrix. Then eigen value of A are:- **(1)**

a) 1, -1 **b)** 1, -i **c)** i, -i **d)** -1, i

Q. 27. Generally, the convolution process associated with the Laplace Transform in time domain results into:- **(1)**

a) Simple multiplication in complex frequency domain
b) Simple division in complex frequency domain
c) Simple multiplication in complex time domain
d) Simple division in complex time domain

Q. 28. Unilateral Laplace Transform is applicable for the determination of linear constant coefficient differential equations with:- **(1)**

a) Zero initial condition **b)** Non-zero initial condition
c) Zero final condition **d)** Non-zero final condition

Q. 29. The equation $y^2 = cx$ is general solution of:- **(1)**

a) $y' = 2y / x$ **b)** $y' = 2x / y$ **c)** $y' = y / 2x$ **d)** $y' = x / 2y$

Q. 30. $\begin{pmatrix} 2 & -3 \\ 2 & -2 \end{pmatrix}$ is an operator on R^2. The invariant subspaces of the operator are:- **(1)**

a) R^2 and the subspace with base $\{(0,1)\}$
b) R^2 and the zero subspace
c) R^2, the zero subspace and the subspace with base $\{(1,1)\}$
d) only R^2

PART-B (DESCRIPTIVE TYPE)

SHORT ANSWER TYPE QUESTIONS:-

Q.1. If H is Hermitian matrix and U is unitary matrix. Prove that $U^{-1}HU$ is Hermitian. **(5)**

Q.2. Using Rodrigues formula, prove that $\int_{-1}^{1} x^m P_n(x)dx = 0$ **(5)**

Q.3. Prove that curl of a vector is always solenoidal in nature. **(5)**

Q.4. Find the Fourier series of the function e^x in the interval $-\pi < x < \pi$. **(5)**

LONG ANSWER TYPE QUESTIONS:-

Q.5. State and prove Cauchy Residue Theorem for analytic function and find the value of integral

$$I=\int_0^{2\pi} \frac{d\theta}{2+\cos\theta}$$ **(10)**

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Sr.No. 100771 Roll No. _____

M.Sc.(PHYSICS) – 1st SEMESTER EXAMINATIONS; DECEMBER - 2017
(SUB:-MATHEMATICS PHYSICS; PAPER CODE:-09020101)

TIME: 03:00 Hrs. **Max Marks:80**

Instructions:-

1. Write your Roll No. on the Question Paper.
2. Candidates should ensure that they have been provided with correct question paper. Complaints in this regard, if any should be made within 15 minutes of the commencement of the exam. No complaint(s) will be entertained thereafter.
3. Attempt **five (05)** questions in all selecting at least one question from each unit. Marks are indicated against each question.
4. Draw the diagram wherever required.

UNIT-I

Q.1. a) Show that the set of vectors r_1, r_2, r_3 given by:
$r_1 = 2a-3b+c$, $r_2 = 3a-5b+2c$, $r_3 = 4a-5b+c$
a, b, c being non-zero and co-planar vectors, is linearly dependent. (5)

b) Show that if $a_{ijkl...}$ is a symmetric tensor in any two suffixes, then $\bar{a}_{pqrs...}$ Will also be symmetric tensor in the same suffixes. (5)

c) Determine the eigenvalues and eigenvectors of the matrix (6)

$$A=\begin{bmatrix} -5 & 2 \\ 2 & -2 \end{bmatrix}$$

Q.2. a) Define symmetric, skew-symmetric, and orthogonal matrices. (6)

b) Find a basis of eigenvectors and diagonalize of the matrix (10)

$$A=\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$$

UNIT-II

Q.3. find the complete solutions:- (16)

a) $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + 2y = coshx$

b) $\frac{d^2y}{dx^2} - 4y = x^2$

Q.4. a) A series of sin and cosine of multiple of x; which will represent $x + x^2$ in the interval $-\pi < x < \pi$ then find the value of $\sum_{n=1}^{\infty}\frac{1}{n^2} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \ldots..$ (8)

b) If $P_n(x)$ is the Legendre polynomial of order n, then find the value of $3x^2+3x+1$ in terms of P_0, P_1, and P_2. (8)

UNIT-III

Q.5. Find the values of the integrals: (16)

a) $I = \frac{1}{2\pi i}\oint_C \frac{dz}{(z-3)}$; where C is the circle |z|=1.

b) $I = \int_0^{2\pi}\frac{\cos 2\theta d\theta}{(5+4\cos\theta)}$

P T O

Q.6. Find the residue of $\frac{z^4}{(z-1)^4(z-2)(z-3)}$ at z=1. (16)

UNIT-IV

Q.7. Estimate the Laplace transform of: (16)

a) $\text{Sin}(\omega t + \alpha)$

b) t sin at

Q.8. Let f(x) be the function of period 2L = 4 which is given on the interval (-2, 2) by (16)

$$f(x) = \begin{cases} 0, & -2 < x < 2 \\ 2 - x, & 0 < x < 2 \end{cases}$$

Find the Fourier series of f(x).

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Sr.No. 100772 Roll No. _____

M.Sc.(PHYSICS) – 1ST SEMESTER EXAMINATIONS; DECEMBER - 2017
(SUB:- CLASSICAL MECHANICS; PAPER CODE:-09020102)

TIME: 03:00 Hrs. **Max Marks:80**

Instructions:-

1. Write your Roll No. on the Question Paper.
2. Candidates should ensure that they have been provided with correct question paper. Complaints in this regard, if any should be made within 15 minutes of the commencement of the exam. No complaint(s) will be entertained thereafter.
3. Attempt **five (05)** questions in all. Attempt at least one question from each unit. All questions carry equal marks. Marks are indicated against each question.
4. Draw the diagram wherever required.

UNIT-I

Q.1. a) What do you mean by generalized forces? Find the expression of it in terms of generalized coordinates. (8)

b) Define constraints. Define the following term with examples: (4+4=8)
a) Holonomic b) Non-holonomic

Q.2. a) Find the equation of motion of one dimensional harmonic oscillator using Hamilton's principle. (8)

b) Prove that the laws of conservation of linear momentum and energy for a system of interacting particles. (8)

UNIT-II

Q.3. a) Obtain the Lagrangian equation of motion using D'Alembert's Principle. Drive an expression for language's velocity dependent forces. (8)

b) Show that kinetic energy is a quadratic function of Generalized velocities. (8)

Q.4. a) Explain Hamiltonian Principle. Use it to drive Lagrange's equations for a conservative and holonomic system. (8)

b) Consider a particle of mass 'm' suspended from a weightless cord of length 'l'. The motion of particle takes place in plane. Obtain the lagrangian & equation of motion. (8)

UNIT-III

Q.5. a) Obtain a general expression for the kinetic energy of a rigid body. (8)

b) Discuss the motion of a symmetric top in the presence of gravitational force field. (8)

Q.6. a) Derive the equation of motion of the orbit for a particle moving under central force field. (8)

b) Define normal coordinate and find eigen frequencies and eigen vectors of a system of a linear triatomic molecule system. (8)

P.T.O.

UNIT-IV

Q.7. a) What is Canonical transformation? Obtain the equation of Canonical transformation taking different form of generating functions? (8)

b) If H is the Hamiltonian and f is any function depending on position, momenta and time, show that $\frac{df}{dx} = \frac{\partial f}{\partial t} + [f, H]$ (8)

Q.8. a) Explain the significance of Poisson's Bracket. Prove that (8)

$$[f_1, f_2, g] = f_1[f_2, g] + f_2[f1, g]$$

b) Obtain Hamiltonian – Jacobi equation for a system and discuss complete integral of the equation. (8)

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Sr. No. 100772 Roll No.

M.SC. (PHYSICS) - 1ST SEMESTER EXAMINATIONS; DEC.-2017

(SUBJECT: CLASSICAL MECHANICS; PAPER CODE – 09020102)

Time: 03:00 Hrs. **Max Mark: 60**

Instructions:

1. Write your Roll No. on the Question Paper.
2. Candidate should ensure that they have been provided with the correct question paper. Complaints in this regards, If any, should be made within 15 minutes of the commencement of the exam. No complaint(s) will be entertained thereafter.
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PART-A (OBJECTIVE TYPE QUESTIONS OMR SHEETS)

ATTEMPT ALL QUESTIONS:-

Q. 1. The number of degrees of freedom for the case when a sphere is constrained to roll without slipping on a plane are:- **(1)**

a) 2 **b)** 5 **c)** 3 **d)** 6

Q. 2. The generalized coordinates of a system:- **(1)**

a) need not necessarily have the same dimension **b)** must have the same dimension
c) are unique **d)** have dimensions of length

Q. 3. Constraint in a rigid body is:- **(1)**

a) holonimic **b)** nonholonomic **c)** scleronomic **d)** rheonomic

Q. 4. Which is not an example of ideal constraint:- **(1)**

a) frictionless constraint surface **b)** rolling contact without slipping
c) internal forces on a rigid body **d)** applied forces on a rigid body

Q. 5. If a coordinate is cyclic, Hamiltonian would reduce the number of variables in new formulation by:- **(1)**

a) four **b)** three **c)** two **d)** one

Q. 6. If the Lagrangian is invariant under translation, then the following is conserved:- **(1)**

a) linear momentum **b)** energy **c)** angular momentum **d)** none of these

Q. 7. Egg standing on end is an example of:- **(1)**

a) stable equllibrium **b)** unstable equllibrium **c)** neutral equilibrium **d)** both (a) & (b)

Q. 8. The homogeneity of time leads to the law of conservation of:- **(1)**

a) linear momentum **b)** angular momentum **c)** energy **d)** parity

Q. 9. Normal coordinates are coordinate transformation under which:- **(1)**

a) only V is diagonalized **b)** only T is diagonlized
c) both T & V are diagonalized **d)** none of these

Q. 10. In Hamilton's principle's expression, L has dimension of:- **(1)**

a) energy **b)** action **c)** angular momentum **d)** none of these

Q. 11. "l"has dimensions of:- **(1)**

a) energy **b)** action **c)** angular momentum **d)** helix

Q. 12. The Coriolis force is zero at:- **(1)**

a) equator **b)** north pole
c) south pole **d)** 45 degree south of equator

Q. 13. The frame reference attached to the earth is:- (1)

a) inertial b) non-inertial c) accelerated d) fixed

Q. 14. The Poisson's bracket of two constants of the motion is itself a constant of motion. This Is:- (1)

a) Poisson's equation theorem b) canonical theorem

c) Poisson's theorem d) Jacobi's

Q. 15. Possion's bracket has the relation:- (1)

a) [f,g]=[g,f] b) [f,g]=[g,g] c) [f,g]=0 d) [f,g]= -[g,f]

Q. 16. The range of Eulerian angle y is:- (1)

a) $0 \leq \psi \leq 2\pi$ b) $0 \leq \psi \leq \pi$ c) $-\pi \leq \psi \leq \pi$ d) $\pi \leq \psi \leq 2\pi$

Q. 17. Which is true about Hamilton's principal function S:- (1)

a) $S = \int L dt$ b) $S = Ldt$ c) $S = \int L dt$ + Constant d) none of these

Q. 18. J has the dimension of:- (1)

a) time b) energy c) energy × time d) momentum

Q. 19. Kepler's second law says that:- (1)

a) areal velocity is zero b) areal velocity is constant

c) angular momentum is constant d) none of these

Q. 20. The value of eccentricity for an elliptical orbit is:- (1)

a) $\varepsilon=0$ b) $\varepsilon=1$ c) $\varepsilon>0$ d) $0<\varepsilon<1$

Q. 21. A central force always conserves:- (1)

a) energy b) linear momentum c) angular momentum d) none of these

Q. 22. The product $p_k q_k$ has the dimension of:- (1)

a) energy b) linear momentum c) action d) none of these

Q. 23. For repulsive inverse square forces, the shape of the orbit is:- (1)

a) hyperbola b) ellipitical c) circular d) all of these

Q. 24. A body is called symmetric top if the moment of inertia have the relation:- (1)

a) $I_1=I_2=I_3$ b) $I_1=I_2, I_3=0$ c) $I_1=I_2\neq I_3$ d) $I_1\neq I_2\neq I_3$

Q. 25. Rigid rod is an example of:- (1)

a) rotor b) spherical top c) symmetric top d) asymmetric top

Q. 26. The Lagrangian is a function of:- (1)

a) q_k, p_k b) $\dot{q}_k, q_k$ c) $\dot{p}_k, q_k$ d) $p_k, \dot{p}_k$

Q. 27. The canonical equations of motion are:- (1)

a) $\dot{j} = -\frac{\partial H}{\partial \theta}, \dot{\theta} = -\frac{\partial H}{\partial J}$ b) $\dot{j} = -\frac{\partial H}{\partial \theta}, \dot{\theta} = \frac{\partial H}{\partial J}$ c) $\dot{j} = \frac{\partial H}{\partial \theta}, \dot{\theta} = -\frac{\partial H}{\partial J}$ d) $\dot{j} = \frac{\partial H}{\partial \theta}, \dot{\theta} = \frac{\partial H}{\partial J}$

Q. 28. If the lagrangian does not depend on time explicitly:- (1)

a) the Hamiltonian is constant b) the Hamiltonian cannot be constant

c) the kinetic energy is constant d) the potential energy is constant

Q. 29. For the Hamiltonian , $H=\frac{p^2}{2m}+\frac{1}{2}kq^2$ the Lagrangian is:- (1)

a) $\frac{1}{2}m\dot{q}^2+\frac{1}{2}kq^2$ b) $\frac{1}{2}m\dot{q}^2-\frac{p^2}{2m}-\frac{1}{2}kq^2$ c) $\frac{p^2}{2m}-\frac{1}{2}kq^2$ d) $\frac{1}{2}m\dot{q}^2-\frac{1}{2}kq^2$

Q. 30. For the potential $V = kr^2$ $(k>0)$, the closed orbit is:- (1)

a) circle b) parabola c) hyperbola d) ellipse

PART-B (DESCRIPTIVE TYPE)

LONG ANSWER TYPE QUESTIONS:-

Q.1. Deduce the Lagrange's equation from Hamilton's Principle. Hence obtain Hamilton's equation of motion for free particle. **(10)**

SHORT ANSWER TYPE QUESTIONS:-

Q.2. Obtain Lagrange's equation of motion for a simple harmonic oscillator. **(5)**

Q.3. Explain Euler angles. **(5)**

Q.4. Obtain Hamilton's equation of motion from variation principle. **(5)**

Q.5. Define Poisson's Bracket. Hence prove that:- **(5)**

$[f_1 f_2, g] = f_1[f_2, g] + f_2[f_1, g]$

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Sr. No 100773 Roll No. _____

M.SC (PHYSICS) – 1ST SEMESTER EXAMINATION; DECEMBER-2017
(SUBJECT- QUANTUM MECHANICS-I; PAPER CODE- 09020103)

Time : 03:00 Hours Maximum Marks –60

Instruction :

1. Write your Roll No. on the question paper.
2. Candidate should ensure that they have been provided with correct question paper. Complaints in this regard, if any, should be reported to the invigilator on duty in the examination hall within 15 minutes of the commencement of the exams. No complaints shall be entertained thereafter.
3. Each part is compulsory. Marks are indicated against each question.
4. Draw diagram wherever required.

Part-A(Objective type questions OMR sheets)

Objective type questions (each question carries one mark)

(1x30=30)

1. The wavelength associated with an electron of energy E = 100 eV is equal to

(a)0.123 nm (b) 12.3 nm (c) 123 nm (d) 1230 nm

2. The expression of the momentum of a photon is

(a) $p = h\lambda$ (b) $p = h/\lambda$ (c) $p = c/\lambda$ (d) $p = c\lambda$

3. A solid body heated to a very high temperature T emits radiation power proportional to

(a) T (b) T^2 (c) T^4 (d) T^3

4. The degeneracy of the third energy level of a 3-dimensional isotropic quantum harmonic oscillator is

(a) 6 (b) 12 (c) 8 (d) 10

5. The amount of movement p of a free particle is linked to the wave vector k of the wave associated to the particle by

(a) $p = k/2\pi$ (b) $p = h\bar{k}/2\pi$ (c) $p = k/\lambda$ (d) $p = 2\pi k/\lambda$

6. According to the theory of Bohr, the energy values of the electron in a hydrogen atom is given by:

(a) $E_n = -13.58/n$ eV (b) $E_n = -13.58/n^2$ eV (c) $E_n = 13.58/n$ eV (d) $E_n = 13.58/n^2$ eV

n being a positive integer : $n = 1,2,3,.....\infty$

7. In the probabistic interpretation of wave function Ψ, the quantity $|\Psi|^2$ is

(a) a probability density (b) a probability amplitude (c) 1 (d) 0

8. In quantum mechanics, a dynamical variable is governed by a Hermitian operator called an observable that has an expectation value that is

(a) The most likely value of the quantity given by the probability density: i.e., the mode of the probability density

(b) The median value of the quantity given by the probability density

(c) The mean value of the quantity given by the probability density

(d) Any value you happen to measure.

9. The expectation value of operator Q for some wave function is often written

(a) Q (b) >Q< (c) <Q> (d) <f(Q)>

10. The momentum operator in one-dimension is

(a) $-h\,\partial/\partial x$ (b) $(h/2\pi\, i)\,\partial/\partial x$ (c) $(i/h)\,\partial/\partial x$ (d) $-i\,h\,\partial/\partial t$

11. Which of the following is an accurate statement concerning the simple harmonic oscillator?

(a) The potential energy varies linearly with displacement from equilibrium

(b) The spacing between energy levels increases with increasing energy

(c) The wave functions are sinusoidal functions

(d) The number of nodes of the wave function increases with increasing energy

12. How does the probability of an electron tunneling through a potential barrier vary with the thickness of the barrier?

(a) It decreases inversely with thickness

(b) It decreases sinusoidally with thickness

(c) It decreases linearly with thickness

(d) It decreases exponentially with thickness

13. The wave function for a particle must be normalizable because

(a) The particle must be somewhere.

(b) The particle's momentum must be conserved

(c) The particle cannot be in two places at the same time

(d) The particle's angular momentum must be conserved

14. Which of the following problem in physics was created by quantum mechanics?

(a) The particle/wave duality

(b) The ultraviolet catastrophe of blackbody radiation

(c) The twin paradox

(d) The contradiction between the universal speed of light and Galilean transforms

(15) When an electron jumps from an orbit where n = 1 to n = 4, its energy in terms of the energy of the ground level (E_1) is:

(a) $E_1/9$ (b) $E_1/16$ (c) $4E_1$ (d) $16E_1$

(16) According to Heisenberg's Uncertainty Principle:

(a) $\Delta x\Delta p \leq h/2\pi$ (b) $\Delta x\Delta p > h/4\pi$ (c) $\Delta x\Delta p \geq h/4\pi$ (d) None of the above

(17) When the potential V (x) is finite, the derivative of the wavefunction $\partial\Psi/\partial x$ is

(a) discontinuous (b) contiunous (c) infinite (d) zero

(18) The kinetic energy of photoelectrons depends on the:

(a) speed of light
(b) angle of illumination
(c) number of incident photons
(d) photon frequency

(19) The spread of the free Gaussian wavepacket:

(a) increases with time
(b) decreases with time
(c) remains same
(d) increases then decreases with time

(20) A linear operator $\hat{U}$ is said to be unitary operator if (a)

$\hat{U}\hat{U} = \hat{I}$ (b) $\hat{U}\hat{U}\dagger = \hat{U}\dagger\hat{U} = \hat{I}$ (c) $\hat{U} + \hat{U}\dagger = \hat{I}$ (d) none of the above

(21) What is the dimension of the Planck's constant h?

(a) $kg\ m^2\ s^{-3}$ (b) $kg\ m^2\ s^{-1}$ (c) $kg^2\ m\ s^{-1}$ (d) $kg^2\ m^2\ s^{-1}$

(22) For the perturbation $\lambda H'$, the expression

$E^{(0)}_n + \lambda\langle\psi^{(0)}_n|H'|\psi^{(0)}_n\rangle$ is the

(a) eigen energy of eigen state n to 0^{th} order in perturbation

(b) eigen energy of eigen state n to 1^{st} order in perturbation

(c) eigen state n to 1^{st} order in perturbation

(d) eigen state n to 2nd order in perturbation

(23) Let φ_n be the properly-normalized n^{th} energy eigenfunction of the harmonic oscillator, and let $\psi = \hat{a}\hat{a}^\dagger\varphi_n$. Which of the following is equal to ψ?

(a) φ_n (b) $n\,\varphi_{n-1}$ (c) $(n+1)\,\varphi_n$ (d) $n\,\varphi_{n+1}$

(24) An electron with energy E is incident from left on a potential barrier, given by

$V(x) = 0$ for $x < 0$

$V(x) = V_0$ for $x > 0$.

For $E < V_0$, the space part of the wave function for $x > 0$ is of the form

(a) e^{ax} (b) e^{-ax} (c) e^{iax} (d) e^{-iax}

(25) Which one of the following objects, moving at the same speed, has the greatest de Broglie wavelength?

(a) Cricket ball (b) Tennis ball (c) Neutron (d) Electron

(26) The selection rule for m for transitions which occurs from one energy level to another as a result of electromagnetic radiation incident on an atom is:

(a) $\Delta m = 0$ (b) $\Delta m = \pm 1$ (c) $\Delta m = +1$ (d) $\Delta m = 0, \pm 1$

(27) The energy eigenvalues of the hydrogen atom

(a) Depend on all three quantum numbers n, l, and m

(b) Depend on n and l, but not on m

(c) Depend on n but not on l and m

(d) Depend on n and m, but not on l

(28) Two eigen functions of the Hermitian operators, belonging to different eigenvalues are

(a) Similar (b) normalized (c) orthogonal (d) none of the above

(29) If the width of the infinite 1D potential is doubled, how is the energy of the ground state going to change?

(a) Increase by factor 2

(b) increase by factor 4

(c) Decrease by factor 4

(d) remain the same

(30) The degenerate energy eigen states are states which have

(a) Same eigenvalues

(b) not all eigenvalues are same

(c) large eigenvalues

(d) none of the above

Part- B (Descriptive type)

Short answer type questions (each question carries 4 marks)

(4x5=20)

(31) What do you mean by normalized and orthogonal wave functions?

(32) Obtain the commutation relations of total angular momentum with its components

(33) State and prove Ehrenfest's Theorem

(34) Describe one experiment to illustrate the validity of the Heisenberg's uncertainty principle.

(35) Write a note on Eigen values and Eigen functions of an operator.

Long Answer Type Question **(1x10=10)**

(36) Develop the stationary perturbation theory for non-degenerate states in first and second orders and shaow that the second correction to the energy of the normal state always negative

Or

Explain the Stark Splitting of n=2 of hydrogen atom in the presence of electric field using first order time independent perturbation theory.

15

Sr. No 100773(RE) Roll No. _____

M.SC (PHYSICS) – 1st SEMESTER EXAMINATION; DECEMBER-2017
(SUBJECT- QUANTUM MECHANICS-I; PAPER CODE- 09020103)

Time : 03:00 Hours **Maximum Marks –80**

Instruction :

Write your Roll No. on the question paper.

1. Candidate should ensure that they have been provided with correct question paper. Complaints in this regard, if any, should be reported to the invigilator on duty in the examination hall within 15 minutes of the commencement of the exams. No complaints shall be entertained thereafter.
2. Attempt FIVE (05) questions in all. Students are required to attempt five (05) questions selecting at least one question from each unit.
3. Draw diagram wherever required.

UNIT-I

Q1. a) What do you mean by normalized and orthogonal wave functions? (4)

b) Define probability current density. (4)

c) Prove the non-existence of electrons in the nucleus with the help of uncertainty principle. (4)

d) What is quantum mechanical tunnelling? (4)

Q2. a) Derive time independent Schrodinger equation and discuss the concept of stationary states and wave packet. (8)

b) The average lifetime of an excited atomic state is 10^{-9} s. If the spectral line associated with the decay of this state is 6000 A^0 , estimate the width of the line. (8)

UNIT-II

Q3. a) Show that the expectation and eigenvalues of operators do not change with unitary transformation. (8)

b) Solve the Schrodinger equation for a linear harmonic oscillator and determine the normalized wave-function and energy levels of the oscillator. (8)

Q4. a) State and explain the fundamental equations of the Heisenberg method. (8)

b) Define the Hermitian operator. Show that the eigen values of a Hermitian operator are real. (8)

UNIT-III

Q5. a) How many angular momentum states arise for a system with two angular momenta $j_1 = 1$ and $j_2 = ½$. Specify the states. (8)

b) Define angular momentum operator in terms of communication relations between its components and show that $[J_+ , J_-] = 2h J_z$ (8)

Q6. a) State the eigenvalue – eigenvector relations for the operators J^2 and J_Z. Hence obtain the matrics for J^2 and J_z (8)

b) Discuss the Stern-Gerlach experiment and derive the expression for the momentum of spin up components. (8)

P.T.O.

UNIT-IV

Q7. a) Discuss the advantages of variational method and estimate the interaction energy of electrons. (8)

b) Develop the stationary perturbation theory for non-degenerate states in first and second orders and show that the second correction to the energy of the normal state always negative. (8)

Q8. a) Explain the Stark Splitting of n=2 of hydrogen atom in the presence of electric field using first order time independent perturbation theory. (8)

b) A linear harmonic oscillator is perturbed by a additional potential energy bx^3. Calculate the change in each energy level to 2^{nd} order in the perturbation. (8)

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Sr. No 17774 Roll No. _____

M.SC (PHYSICS) – 1st SEMESTER EXAMINATION; DECEMBER-2017

(SUBJECT- ELECTRONIC DEVICE ; PAPER CODE- 09020104)

Time : 03:00 Hours **Maximum Marks –80**

Instruction :

Write your Roll No. on the question paper.

1. Candidate should ensure that they have been provided with correct question paper. Complaints in this regard, if any, should be reported to the invigilator on duty in the examination hall within 15 minutes of the commencement of the exams. No complaints shall be entertained thereafter.
2. Attempt FIVE (05) questions in all selecting at the least tone question from each unit. Make are indicated
3. Draw diagram wherever required.

UNIT-I

Q1. a) Describe the construction, operation and V-1 characteristics of an n- channel enhancement MOSFET. (8)

b) What is the origin of diffusion currents in a pn-diode? Hence derive expression for diffusion currents due to electrons and holes in a pn-diode. (8)

Q2. a) Sketch a physical structure of an n-channel FET and then explain its operation and V-1 characteristics. (8)

b) Using charge neutrality condition, find expressions of free carrier concentrations in n-and p-type semiconductors. How such expressions would modify if n- and P-semiconductors are also doped with trivalent and pentavalent impurities respectively . (8)

UNIT-II

Q3. What are thermistors? Describe in detail their various characteristics. Also list a few important applications of thermistors. (16)

Q4. Discuss in detail the construction and operation of a diode laser and a photo diode. (16)

UNIT-III

Q5. a) Define CMMR. On what factors it depends? Describe a circuit to determine it experimentally. (8)

b) Explain the concept of virtual ground in an OPAMP. Invoking it, determine the closed loop gain of an ideal OPAMP in inverting and non-inverting modes of operation. (8)

Q6. a) Describe the operation of an emitter coupled differential amplifier. Also determine gain of this circuit under common and differential modes of operation. (8)

b) Explain the operations of OPAMP based integrator and voltage comparator circuits. (8)

UNIT-IV

Q7. a) Describe the operation of an ECL logic gate. Also list its advantages and disadvantages. (8)

b) List the advantages of CMOS logic gates and then describe the operation of a CMOS NOR gate. (8)

Q8. a) Explain the operation of a HTL NAND gate. Also give noise immunity of this gate under various input conditions. (8)

b) Simplify the expression using K-map (8)

$$f(A,B,C,D) = \sum 0,3,4,5,7 + \sum_{\varphi} 9,12,13,14,15$$

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IV

Sr. No 100774 Roll No. ____

M.SC (PHYSICS) – 1ST SEMESTER EXAMINATION; DECEMBER-2017
(SUBJECT- ELECTRONIC DEVICES; PAPER CODE- 09020104)

Time : 03:00 Hours **Maximum Marks 60**

Instruction :

1. Write your Roll No. on the question paper.
2. Candidate should ensure that they have been provided with correct question paper. Complaints in this regard, if any, should be reported to the invigilator on duty in the examination hall within 15 minutes of the commencement of the exams. No complaints shall be entertained thereafter.
3. Each part is compulsory. Marks are indicated against each question.
4. Draw diagram wherever required.

PART – A (OBJECTIVE Type Questions OMR Sheet)

Attempt all Questions. **(30x1=30)**

Q1. In a reverse bias PN Junction, almost no current flows because

a) electrons and holes recombine before they can cross the junction

b) Only minority carriers, whose densities are very small, contribute to the current, when they cross the junction

c) The electric field in the neutral regions is very small

d) all the applied voltage appears across the ohmic contacts

Q2. Transition Capacitance of a PN Junction is of significance, when

a) It is reversed biased. b) It is forward biased.

c) It is unbiased d) It is highly doped

Q3. A tunnel diode

a) exhibits negative resistance characteristics in reversed biased region

b) exhibits negative resistance characteristics in forward biased region

c) does not exhibits negative resistance characteristics in forward biased region

d) exhibits negative resistance characteristics in reversed biased region only when it is ideal

Q4. The electric power output of a photodiode is maximum when a

a) Small reverse bias exist across it

b) large reverse bias exist across it

c) Small forward bias exist across it

d) Small forward current flows through it, irrespective of the bias

Q5. In today's world, the almost exclusive logic family used for making digital circuits is

a) NMOS b) RTL

c) TTL d) CMOS

Q6. Emitter coupled logic (ECL) is the fastest bipolar transistor logic because

a) it uses current, rather than voltages, as the output variables

b) it uses a circuit configuration that prevents the transistors from going in to saturation

c) it has no PNP transistors

d) it uses differential inputs

Q7. In the saturation region, the JFET transfer characteristics are

a) Exponential

b) Linear

c) Parabolic

d) Hyperbolic

Q8. The threshold voltage of a MOSFET is defined as

a) The drain-source voltage at which the transistor goes into saturation

b) The gate-source voltage at which the transistor goes into saturation

c) The drain –source voltage at which the predefined value of drain current starts flowing.

d) The gate –source voltage at which the predefined value of drain current starts flowing.

Q9. In order to control the channel current, a MOSFET uses the electric field of a

a) Capacitor b) Battery

c) Generator d) Metal oxide layer

Q10. The 2's complement of the number 01001110 is

a) 00110101 b) 10110010

c) 11001011 d) 10101010

Q11. The equivalent decimal number of octal number $(6327.4051)_8$ is

a) $(3287.5100098)_{10}$ b) $(3286.5100088)_{10}$

c) $(3286.5100078)_{10}$ d) $(3286.5100068)_{10}$

Q12. The equivalent hexadecimal number of decimal number (675.625) is

a) $(3A2.A)_{16}$ b) $(2A3.B)_{16}$

c) $(2A3.A)_{16}$ d) $(2B3.A)_{16}$

Q13. If the reverse bias on the gate of a JFET is increased, then width of the conducting channel will

a) Decrease b) Increase

c) Remain constant d) None of above

Q14. The input control parameter of a JFET is

a) Gate current b) Source voltage

c) Drain voltage d) Gate voltage

Q15. Which of the following devices has the highest input impedance?

a) JFET b) MOSFET

c) Ordinary Transistor d) Zener Diode

Q16. The SCR is turned off by

a) Reducing anode voltage to zero

b) Reducing gate voltage to zero

c) Reverse biasing the gate

d) Increasing the anode voltage

Q17. In normal operation of an SCR, the potential on anode with respect to cathode is .

a) Zero b) Negative

c) Positive d) None of above

Q18. In normal operation of an SCR, the potential on gate with respect to cathode is

a) Zero b) Negative

c) Positive d) None of above

Q19. The maximum anode current, gate being open, at which SCR is turned off from ON condition is

a) Forward current b) Reverse current

c) Leakage current d) Holding current

Q20. The minimum forward voltage, gate being open, at which SCR is turned on is

a) breakdown voltage b) break-over voltage c) peak reverse voltage d) Zener voltage

Q21. A tunnel diode, when operated in the negative resistance region can be used as

a) an amplifier b) rectifier c) switch d) modulator

Q22. In differential mode of OP AMP

a) only one supply voltage is used. b) the gain is one

c) the outputs are of different amplitudes d) opposite polarity signals are applied to the inputs

Q23. In the common mode of an OP AMP

a) both inputs are grounded b) the outputs are connected together

c) an identical signal appears on both inputs d) the out signals are in phase

Q24. For an OP AMP with negative feedback, the output is

a) equal to the input b) feedback to the inverting inputs

c) increase d) feedback to the non-inverting input

Q25. The use of negative feedback

a) reduces the voltage gain of an OP AMP b) makes the OP AMP oscillate

c) decrease the stability of an amplifier d) none of above

Q26. Negative feedback

a) increases the input and output impedances

b) increases the input impedance and bandwidth

c) decreases the output impedance and bandwidth

d) does not affect impedance or bandwidth

Q27. A voltage follower has voltage gain

a) 1 b) 2 c) 5 d) 7

Q28. The common mode voltage gain is

a) Equal to the differential voltage gain

b) Greater than the differential voltage gain

c) Double then the differential voltage gain

d) Smaller than the differential voltage gain

Q29. The input stage of an OP AMP is usually a

a) differential amplifier b) Common Emitter Amplifier

c) Class B Amplifier d) Common collector Amplifier

Q30. Current cannot flow to ground through

a) a mechanical ground b) an a.c. ground c) virtual ground d) an ordinary ground.

PART – B (Descriptive Type) (3x4=12)

Short Answer Type Question

From question number 1-6, Attempt any four

Q1. Give the structure of an n-channel enhancement MOSFET..

Q2. Sketch the volt – ampere characteristics of a tunnel diode. Indicate the negative resistance portion.

Q3. What do you mean by solar cell. Explain fill factor and efficiency of solar cell.

Q4. Explain the effects of negative feedback on closed loop voltage gain of an operational amplifier.

Q5. Draw circuit of DTL and explain its working.

Q6. Explain the working of operational amplifier as diffrentiater.

From question number 7 – 14, attempt any Five. **(2x5=10)**

Q7. How you will use JFET as a switch?

Q8. What are characteristics of an ideal OP AMP?

Q9. Explain in brief Light Emitting Diode.

Q10. Differentiate between Radiative and non-Radiative transitions.

Q11. What are Inverting and Non-inverting inputs in operational amplifier?

Q12. What is the effect of feedback on band width of an operational amplifier?

Q13. Give truth table and symbol of NOR gate.

Q14. What are De Morgan's laws?

Long Answer Type Questions (1x8=8)

Attempt any one Question

Q1. Draw the circuit diagram of CMOS as a switch and explain its working . Give a reason why CMOS become very popular in logic circuits.

Q2. Draw the circuit of TTL gate and explain its operation

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