(6 pages) **Reg. No. :** .....

Code No. : 6038 **Sub. Code : PPHM 41**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Fourth Semester

Physics – Core

QUANTUM MECHANICS – II

(For those who joined in July 2017-2020)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. $[L^2, L_x]$ is equalent to

   (a) zero (b) $\hbar L_+$

   (c) $\hbar L_-$ (d) $i\hbar$

2. The spin value of neutron is

   (a) $\frac{1}{2}$ (b) $-\frac{1}{2}$

   (c) $\frac{1}{2}\hbar\sigma$ (d) 1

3. The Hamiltonian H of perturbed system is

(a) $H^0 + H^1$ (b) $H^0 + E\psi$

(c) $H^0 + \lambda H^1$ (d) $E_n \psi_n$

4. The polarizability α for hydrogen atom in the ground state is

(a) $-\frac{9}{4} a_0^3$ (b) $-\frac{9}{2} a_0^3$

(c) $\frac{9}{2} a_0^2$ (d) $\frac{9}{2} a_0^3$

5. The number of transitions per unit time is called the

(a) Transition probability

(b) Emission

(c) Scattering

(d) Harmonic perturbation

6. The electric quadrupole transitions are ———— times weaker than electric transitions.

(a) 10^{-8} (b) 10^8

(c) 10^5 (d) 10^7

7. Cross-sections are usually measured in

(a) barns (b) radians

(c) degrees (d) cm^2

8. The scattering amplitude of a two particle system $\sigma(\theta)$ is

(a) $|f(\theta)|$ (b) $|f(\theta)|^2$

(c) $-|f(\theta)|$ (d) $-|f(\theta)|^2$

9. $\square^2$ the De Alembertian operator is,

(a) $\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ (b) $\nabla^2 + \frac{1}{c^2}\frac{\partial^2}{\partial t^{2`}}$

(c) $\nabla - \frac{1}{c}\frac{\partial}{\partial t}$ (d) $\nabla + \frac{1}{c}\frac{\partial}{\partial t}$

10. Dirac matrices are

(a) Hermitian (b) Hamiltonian

(c) 2×2 matrices (d) None

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Write the matrix representation of L^2, L_z and $L_{\pm}$.

Or

(b) Give the significance of spin angular momentum.

12. (a) Calculate $E_n^{(2)}$ using Dalgarno and Lewis method.

Or

(b) Consider a particle is a box with the Hamiltonian $H = H^{(0)} + H^{(1)}, H^{(0)} = P_x^2 / 2m + V_{(x)}$ where

$$V(x) = \begin{cases} 0, & for|x| \leq \pi/2 \\ \infty & for|x| > \pi/2 \end{cases},$$

$$H^{(1)} = \begin{cases} \alpha x, & for|x| \leq \pi/2 \\ 0, & for|x| > \pi/2 \end{cases}$$

Determine $E_0^{(2)}$ of the particle.

13. (a) Write any five features of first order transition probability.

Or

(b) Make a short note on adiabatic perturbation.

14. (a) Briefly outline the classical theory of scattering cross-section.

Or

(b) Comment on first Born approximation for scattering amplitude.

15. (a) Give the inadequacies of Klein-Gordon equation.

Or

(b) Derive $\frac{\partial \rho}{\partial t} + \nabla . J = 0$ from Dirac's equation.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) What is spin-orbit interaction? Explain in detail about spin-orbit coupling for an electron.

Or

(b) Obtain Clebsch-gorden co-effcients using the addition theory of angular momenta

17. (a) Elaborate the theory for degenerate levels.

Or

(b) Give an account on first order stark effect in hydrogen atom.

18. (a) Discuss the semiclassical theory of radiation.

Or

(b) Derive Einstein co-efficients for an atom.

19. (a) Discuss the scattering cross section theory and obtain the differential cross section relations for centre of mass and laboratory coordinates systems.

Or

(b) Find the scattering amplitude using Green's function method.

20. (a) Show that for a Dirac particle orbital angular momentum is not conserved but the sum of orbital angular momentum and spin angular momentum is conserved

Or

(b) Derive Dirac equation of Hydrogen atom.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6039 **Sub. Code : PPHM 42**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Fourth Semester

Physics – Core

SPECTROSCOPY

(For those who joined in July 2017-2020)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. In microwave spectroscopy _____ detector is used

   (a) Mica (b) Silica

   (c) Quartz (d) Nickel

2. _____ type of rotation is possible in linear polyatomic molecules.

   (a) 1 (b) 2

   (c) 3 (d) 4

3. Far infrared region is also called as ———— region.

(a) Over tone (b) Vibration

(c) Rotation (d) Spin

4. Which of the following is the reference that is generally used in FTIR interferometer?

(a) Air (b) NaCl solution

(c) Alcohol (d) Base solution

5. The difference types of energy associated with a molecule posses

(a) Electronic energy (b) Vibrational energy

(c) Rotational energy (d) All the above

6. In linear molecules, the Raman shift of first Stokes and anti stokes lines from the exciting line is

(a) 6 B cm^{-1} (b) 12 B cm^{-1}

(c) 14 B cm^{-1} (d) 2 B cm^{-1}

7. Transit ion between electronic states is referred as

(a) IR spectroscopy

(b) Ultraviolet region

(c) both (a) and (b)

(d) Infrared region

8. ESR spectrum is usually recorded in the

(a) Third derivative mode

(b) Second derivative mode

(c) First derivative mode

(d) Fourth derivative mode

9. Hydrogen cyanide exhibits ———————— Raman lines

(a) 2 (b) 3

(c) 4 (d) 5

10. In the absence of absorption power of Raman emission increases with ———————— power of frequency of the source

(a) First (b) Second

(c) Third (d) Fourth

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Explain with suitable examples and diagram, symmetric top (prolate and oblate) spherical top and asymmetric top molecules. Differentiate them.

Or

(b) Give the theory of isotope effect in relation to vibrational bands of a diatomic molecules and discuss the importance of its study.

12. (a) Give a brief account of vibrational spectra of diatomic molecules.

Or

(b) Describe the working of IR spectrometer with a neat diagram.

13. (a) Discuss how Raman spectroscopy is used in the determination of XY_3 molecules structure.

Or

(b) Describe the quantum theory of Raman effect.

14. (a) Explain the principle of ESR and appearance of hyperfine structure.

Or

(b) What will be the frequency of radiation for resonance for a free electron placed in a magnetic field strength of 0.3T.

15. (a) Discuss in detail reflection absorption Infra-red spectroscopy.

Or

(b) Explain the surface enhanced Raman scattering.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b)

16. (a) Describe the theory of microwave spectroscopy in the case of diatomic molecules as a rigid rotator.

Or

(b) In microwave spectroscopy discuss the case of Symmetric top molecule.

17. (a) Explain the rotational levels for two vibrational states and the transitions of the perpendicular vibrations of a linear polyatomic molecule.

Or

(b) Discuss the theory of Infrared spectroscopy in the case of simple harmonic oscillator.

18. (a) Discuss the main features of the vibrational and rotational Raman spectra of diatomic molecules. Give the necessary theory.

Or

(b) Describe the working of Raman spectrometer with a neat diagram.

19. (a) Describe the construction and working of a ESR spectrometer.

Or

(b) Derive Bloch equations. Describe its importance in NMR.

20. (a) Give a brief account of electron energy loss spectroscopy.

Or

(b) Explain in detail X-Ray photoelectron spectroscopy.

———————

(7 pages) **Reg. No. :** .....

Code No. : 6040 **Sub. Code : PPHM 43**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Fourth Semester

Physics – Core

NUCLEAR AND PARTICLE PHYSICS

(For those who joined in July 2017-2020 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The quadruple moment of duetron Q is _____.

(a) 0.0028×10^{-28} cm^2 (b) 0.00028×10^{-28} cm^2

(c) 0.0028×10^{-23} cm^2 (d) None

2. There are no bound duetrons with nuclear spons essentially ————————.

(a) Parallel (b) Antiparallel

(c) Zero (d) None

3. ———————— decay interaction has extremely short range.

(a) α (b) β

(c) γ (d) δ

4. Electrons emitted in β decay have their spons preferentially ———————— to their direction of travel.

(a) Parallel (b) Perpendicular

(c) Antiparallel (d) None of the above

5. The value of z and / or N for a nucleus which shows a significant departure from the average bevaiour by being unusually ———————— are called magic numbers.

(a) Stable

(b) Unstable

(c) Neither stable nor unstable

(d) None

6. E_2 transitions in heavy nucleus are ———— times faster than predicted by the single particle model.

(a) 10^4 (b) 10^3

(c) 10^2 (d) 10

7. If Q is positive the reaction is called ————.

(a) Endoergic (b) Endomeric

(c) Exomeric (d) Exoergic

8. According to Briet – Wunger nuclear cross-section

(a) Directly proportional to velocity of neutron

(b) Inversly proportional to square root of velocity of neutron

(c) Inversly proportional to velocity of neutron

(d) Inversly proportional to square of velocity of neutron

9. The life time of the muoh is ———— second.

(a) 10^6 (b) 10^3

(c) 10^9 (d) 10^{-6}

10. The particles associated in strong interaction is ————.

(a) Photon (b) Pion

(c) Intermediate Boson (d) Granton

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Discuss in detail the P – P scattering at low energies.

Or

(b) Explain briefly exchange forces and the effects of exchange forces.

12. (a) What is meant by internal conversion? Explain.

Or

(b) Explain Gammon Teller selection rule in β-decay and into an example of Gamow Teller allowed transition.

13. (a) Write the limitations of the shell model. Discuss vibrational and rotational states of collective model.

Or

(b) Explain how liquid drop model explains the properties of nucleus. Bring out the limitations of liquid drop model.

14. (a) Explain reciprocity theorem in nuclear forces.

Or

(b) Derive Fermi age equation.

15. (a) State and prove CPT Theorem.

Or

(b) Explain quark model and its significance.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b)

16. (a) By assuming a suitable potential, solve the deutron problem and obtain the nature of ground state of deutron.

Or

(b) Give an account of neutron-proton scattering at low energies and estimates the total scattering cross-section.

17. (a) Outline the Fermi theory of beta decay. Also obtain the expression for the emitted β-spectrum.

Or

(b) Outline Gamows theory of $\alpha-$ decay. Explain with Gamows theory how $\alpha-$ particles with energies less than the height of the potential barrier are emitted them radioactive nucleic.

18. (a) Explain how the collective nuclear model is able to overcome the discrepancies caused in the shell model.

Or

(b) Illustrate with examples any eight evidences for the existence of magic numbers.

19. (a) Explain the terms cross-section of nuclear reaction – Explain Brect Winger one level formula for the cross-section. How the width of the resonance level can be obtained from the formula?

Or

(b) Derive the expression for the Q value of a nuclear reaction and obtain the general solution of Q-equation. Explain exoergic and endogenic equations.

20. (a) Discuss the classification of elementary particles.

Or

(b) Construct the quark wave functions and explain in detail Baryon Decuplet.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6383 **Sub. Code : ZPHM 11**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022

First Semester

Physics – Core

CLASSICAL MECHANICS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. ———————— constraints are those which are expressible in the form of equation $f(r_1, r_2, r_3 .... r_n, t) = 0$

   (a) Holonomic

   (b) Nonholonomic

   (c) Either holonomic and Nonholonomic

   (d) None

2. D'Alembert's principle is based on the principle of ————————

(a) Virtual power

(b) Natural work

(c) Virtual work

(d) None

3. ————————between two particles are the most important examples of central force.

(a) Gravitational and couloumb force

(b) Gravitational and Vanderwalls force

(c) Gravitational and Yukura force

(d) None

4. Coriolos forces are ———————— forces

(a) intertial (b) non fictions

(c) nonintertial (d) None

5. The Poisson bracket of x with $P_x[x, P_x]$ = ————————

(a) Zero (b) one

(c) $i\hbar$ (d) $-i\hbar$

6. The principle of least action states that ————

(a) $\Delta\int_{t_1}^{t_2}\frac{T}{2}dt = 0$ (b) $\Delta\int_{t_1}^{t_2}2Tdt = 0$

(c) $\Delta\int_{t_1}^{t_2}(T-v)dt = 0$ (d) $\Delta\int_{t_1}^{t_2}\sum_{k}p_k q_k dt = 0$

7. In small oscillators each oscillation with definite frequency is known as

(a) Transverse vibration

(b) Longitudinal vibration

(c) Transverse and Longitudinal vibration

(d) Normal vibration

8. In the case of a rigid body having N particles , the number of degrees of freedom is

(a) N (b) 3N

(c) 3 (d) 0

9. Lorentz transformation are merely the orthogonal transform of four dimensional space and later recognized at space

(a) Euclidian (b) Hilbert

(c) Monkowski's (d) None

10. Which one of the following remains invariant under Lorentz transformations

(a) $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$

(b) $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}$

(c) $\frac{\partial}{\partial x}+\frac{\partial}{\partial y}+\frac{\partial}{\partial z}-\frac{1}{c^2}\frac{\partial}{\partial t}$

(d) $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}+\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Find the Lagrange's equation of motion for an electrical circuit comprising an inductance L and capacitance C. The capacitor is charges to q coulombs and current flowing in the circuit is "i;' Amp.

Or

(b) State and explain principle of virtual work.

12. (a) Write short notes on coriolis force.

Or

(b) State and prove viral theorem.

13. (a) Deduce Hamilton's equation from variational principle.

Or

(b) Show that Lagranges bracket is unvariantunder canonical transformation?

14. (a) Derive Eulers equation of motion for a rigid body with fixed point.

Or

(b) Derive an expression for moment of inertia of Rigid body.

15. (a) Establish the mass-energy relation $E = mc^2$.

Or

(b) Discuss the relativistic Lagrangian formulation of relativistic mechanics.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) The homogeneity of time implies that the total energy is constant of motion substantiate.

Or

(b) Derive Lagrange's equation from Hamilton's principle.

17. (a) Discuss a two body problem reduced into one body problem. Calculate reduced mass of Hydrogen atom.

Or

(b) State and prove the kepler's Law of planetary motion.

18. (a) Using poison bracket show that the transformation $q = \sqrt{2p}\sin Q \quad p = \sqrt{2p}\cos Q$

Or

(b) Describe Hamilton-Jacobi theory and use it to solve the problem of linear harmonic oscillator .

19. (a) Discuss the vibrations of a linear triatomic molecule.

Or

(b) Explain in detail general theory of small oscillations.

20. (a) What is a four vector potential? Express Maxwells field equations in four vector form.

Or

(b) Write the postulates of special theory of relativity. Also derive and expression for the variation of mass with velocity.

———————

(8 pages)

Reg. No. : .....

Code No. : 6384 **Sub. Code : ZPHM 12**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

First Semester

Physics – Core

MATHEMATICAL PHYSICS – I

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The divergence of a vector field is always

   (a) a vector

   (b) a scalar

   (c) some times a scalar and sometimes a vector

   (d) neither a scalar nor a vector

2. If $\varphi = 4e^{(2x-y+z)}$, then grad φ at $(1, 1, -1)$ is

(a) $4\left(2\hat{i} - \hat{j} + \hat{k}\right)$

(b) $2\hat{i} - \hat{j} + \hat{k}$

(c) $8\hat{i} - \hat{j} + 2\hat{k}$

(d) $3\hat{i} + 6\hat{j} + 9\hat{k}$

3. Which of the following is the Laguerre's equation?

(a) $\frac{d^2y}{dx^2} + (1-x)\frac{dy}{dx} - n\,y = 0$

(b) $\frac{d^2y}{dx^2} - n\,y = 0$

(c) $x\frac{d^2y}{dx^2} + (1-x)\frac{dy}{dx} + ny = 0$

(d) $x\frac{d^2y}{dx^2} + n\,y = 0$

4. The value of $P_1(x)$ is

(a) 1 (b) 0

(c) x^2 (d) x

5. Heat flow equation is

(a) $\nabla^2 \varphi = 0$

(b) $\nabla^2 \varphi = \frac{1}{h^2} \frac{\partial \varphi}{\partial t}$

(c) $\nabla^2 \varphi = 1$

(d) $\nabla^2 \varphi = \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2}$

6. Which of the following represents wave equation for the membrane?

(a) $\frac{\partial^2 u}{\partial y^2} = \frac{1}{v^2} \frac{\partial^2 u}{\partial t^2}$

(b) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 1$

(c) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \frac{1}{v^2} \frac{\partial^2 u}{\partial t^2}$

(d) $\frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial y^2}$

7. If A_{ij} is anti symmetric tensor, then the component A_{11} is

(a) 1 (b) -1

(c) 2 (d) 0

8. The divergence of a contra variant vector A^{μ} is

(a) $A;^{\mu}_{\mu}$ (b) $A;\mu$

(c) A (d) $\nabla\varphi$

9. From the pack of a 52 cards, one is drawn at random, the probability of getting a king is

(a) $\frac{2}{13}$ (b) $\frac{1}{169}$

(c) $\frac{25}{169}$ (d) $\frac{1}{13}$

10. The value of $\Sigma f\left(x-\bar{x}\right)$ is

(a) negative (b) positive

(c) 0 (d) arbitrary

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Check whether the following vector are linearly dependent or independent $(1, 2, -3)$, $(2, 5, 1)$, $(-1, 1, 4)$.

Or

(b) Find a unit vector perpendicular to the surface $x^2 + y^2 - z^2 = 11$ at the point $(4, 2, 3)$.

12. (a) Calculate the Wronskian of the functions $e^{(p-iq)x}$ and $e^{(p+iq)x}$.

Or

(b) State and prove the generating function for Laguerre polynomials.

13. (a) Solve the heat flow equation.

Or

(b) A string of length l fixed at both ends is plucked at a distance d from one fixed point by an amount h. Find the displacement at any position at any instant of time.

14. (a) Show that the transformations of tensors form a group.

Or

(b) Evaluate $\nabla \times \nabla \phi$.

15. (a) State and prove additive law of probability.

Or

(b) The following data are the number of seeds germinating out of 10 on damp filter for 80 sets of seeds. Fit a Binomial distribution to these data:

x :	0	1	2	3	4	5	6	7	8	9	10
f :	6	20	23	12	8	6	0	0	0	0	0

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Verify divergence theorem for the vector $A = x^2 \hat{i} + y^2 \hat{j} + z^2 \hat{k}$ taken over the cube $0 \leq x, y, z \leq 1$.

Or

(b) State and prove Stoke's theorem.

17. (a) Solve $\left(1-x^2\right)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+n\left(n+1\right)y=0$.

Or

(b) Show that

$$\int_{-1}^{1} P_m(x)\,P_n(x)\,dx=0 \text{ for } m\neq n$$

$$\int_{-1}^{1}\left[P_n(x)\right]^2\,dx=\frac{2}{2n+1}.$$

18. (a) Solve the differential equation

$$2x\frac{\partial u}{\partial x}-3y\frac{\partial u}{\partial y}=0.$$

Or

(b) A string of length l with fixed ends is plucked up at its centre a distance h from the position of equilibrium and then released. Find

(i) the displacement at any position at any time

(ii) the normal frequencies and normal modes for the vibrating string.

19. (a) A covariant tensor has components xy, $2y - x^2$, xz in rectangular coordinates. Find its covariant components in spherical coordinates.

Or

(b) Derive Riemann – Christoffel tensor.

20. (a) Calculate:

(i) the quartile

(ii) the mean and

(iii) the standard deviation wages from the following data:

Weakly wages in dollars :	35-36	36-37	37-38	38-39	39-40	40-41	41-42
No. of wage earners:	14	20	42	54	45	18	7

Or

(b) Derive the normal distribution as the limiting case of binomial distribution when $p = q$.

———————

(7 pages) **Reg. No. :** .....

Code No. : 6385 **Sub. Code : ZPHM 13**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

First Semester

Physics – Core

INTEGRATED ELECTRONICS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)
Answer ALL questions.

Choose the correct answer :

1. In the saturation region the $I_D - V_{GS}$ characteristics of a MOSFET are ————

(a) Linear (b) Quadratic

(c) Exponential (d) Hyberbolic

2. In reverse biased condition SCR behaves as ————

(a) Diode (b) Transistor

(c) JFET (d) MOSFET

3. If propagation delay time t_p = 10 ns the outputs change approximately ———— after the arrival of the clock signal.

(a) 20 ns (b) 15 ns

(c) 10 ns (d) 5 ns

4. The circuit responds only where the clock is transaction between its two voltage states ————

(a) RC triggering (b) Level triggering

(c) Edge triggering (d) None

5. Given a choice, integrators are almost invariably preferred over differentiators in analog circuits because

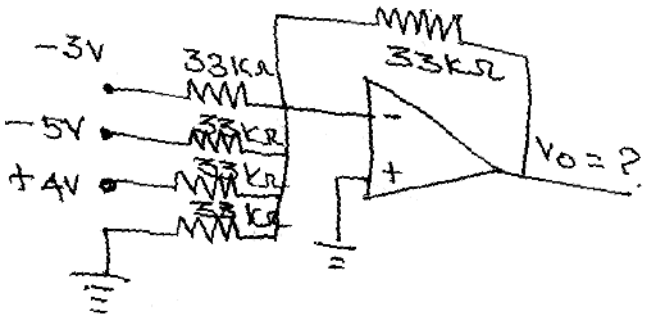
(a) differentiators cause more noise at the output

(b) differentiators don't allow frequency signals to pass

(c) integrators are more immune to low frequency noise

(d) the gain of a differentiator increases with frequency and therefore they are difficult to stabilize with respect to spurious oscillations

6. What is the expected output voltage in the following circuit?



(a) +2V (b) –2V

(c) +4V (d) –4V

7. Monostable multivibrator circuit is sometimes called as ———— multivibrator.

(a) free running

(b) one shot

(c) neither free running nor one shot

(d) none

8. A pulse train has a pulse width 5 ns and a period of 64 ns. Then the duty cycle is ———— percent.

(a) 8.81 (b) 7.81

(c) 6.81 (d) 5.81

9. Shielding is only effective against ———— fields if it provides a low impedance path to ground.

(a) Electric (b) Magnetic

(c) Electro-magnetic (d) Coloumb

10. Signal conditioning often requires the ———— signal to be filtered and isolated to remove unwanted back ground noise.

(a) Output

(b) Input

(c) Neither input and output

(d) None

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Explain the operation of enhancement MOSFET with diagram.

Or

(b) A 100 μm thick silicon wafer has been doped uniformly with Boron of concentration $\frac{10^{16}}{cm^3}$. Find its sheet resistance. Given that for a p-type wafer y is given to be 100 μm and hole mobility in a silicon is 500 $cm^2/V\text{-}S$.

12. (a) What does D-Flip flop do? Explain how JK flip-flop can be converted into D-Flip-flop with diagram and truth table.

Or

(b) Draw the circuit of the integrated DTL gate and explain its operation for positive logic.

13. (a) Explain the action of voltage to current converter using Op-Amp.

Or

(b) Draw the circuit of an Op-Amp differentiator and explain its operation.

14. (a) Draw the internal block diagram of the 555 chip and explain.

Or

(b) Discuss the application of PLL IC for frequency multiplication.

15. (a) Write short notes on electric field shielding.

Or

(b) Explain the DC signal conditioning system with the help of block diagram.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions choosing either (a) or (b).

16. (a) List and explain the steps involved in fabricating a monolithic Integrated Circuit (IC) assuming already have a substrate.

Or

(b) Explain the construction and VI characteristics of the Silicon Controlled Rectifier (SCR) as a function of Gate current.

17. (a) Explain the action of JK flip-flop with neat circuit diagram. Also explain, what is meant by race around condition in connection with JK flip-flop.

Or

(b) Explain the action of a 4 bit ripple counter with circuit diagram and truth table. Also sketch the output waveforms.

18. (a) Sketch the simple hold circuit and explain its operation.

Or

(b) What are the desirable characteristics of instrumentation amplifier and explain its operation with circuit diagram?

19. (a) Explain the action of IC voltage controlled oscillator using IC 566 with block diagram and circuit diagram.

Or

(b) Explain the process of FSK demodulation using PLL.

20. (a) Write the principle of lock in amplifier. Explain the lock in amplifier with block diagram. Also explain the sensitivity of lock in amplifier.

Or

(b) Define noise with reference to electrical system. Classify and explain the noise sources.

———————

(7 pages) **Reg. No. :** .....

Code No. : 6386 **Sub. Code : ZPHM 14**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

First Semester

Physics – Core

NONLINEAR DYNAMCIS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. Linear superposition principle fails completely in ———— system.

   (a) Linear

   (b) Nonlinear

   (c) Linear and nonlinear

   (d) None

2. The condition for underdamping is ————

(a) $2\omega_0 < \alpha < 0$ (b) $0 < \alpha < -2\omega_0$

(c) $0 < \alpha < 2\omega_0$ (d) $-2\omega_0 < \alpha < 0$

3. When real parts of both eigen values are zero then the equilibrium point is ————

(a) stable (b) unstable

(c) neutral (d) none

4. Saddle equilibrium point is ————

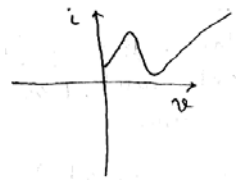
(a) stable

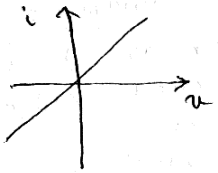
(b) neutrally stable

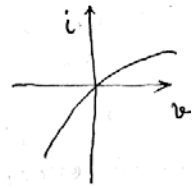
(c) elliptic equilibrium

(d) unstable

5. The $v-i$ characteristic curve of a nonlinear resistor is ————

(a) 

(b) 

(c) 

(d) None

6. AD 712 is an ———— device.

(a) Analog

(b) Digital

(c) Analog and digital

(d) None

7. The fractal dimension of sierpinski triangle is ————

(a) 1.385 (b) 1.485

(c) 1.585 (d) 1.685

8. Generally, chaotic attractors are ————

(a) homogeneous (b) inhomogeneous

(c) linear (d) nonlinear

9. ———— is an example for nonlinear Dispersive system.

(a) Plucking the string on veena

(b) Solitary waves on shallow surfaces

(c) Earth quakes

(d) None

10. Korteveg-de-vires equation is a simple ———— equation.

(a) linear

(b) homogeneous

(c) inhomogeneous

(d) nonlinear

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) For the following systems write the form of forces and the corresponding equation of motion. Identify which of them are linear and which of them are nonlinear.

(i) Anharmonic oscillator

(ii) Damped Harmonic oscillator.

Or

(b) Discuss the motion of the damped linear oscillator.

12. (a) Discuss the occurrence of transcritical bifurcation in the system $\dot{x} = -\mu x + x^2$, $\dot{y} = -y$.

Or

(b) What are limit cycles? Classify and explain limit cycles.

13. (a) Draw the circuit diagram of Bipolar Junction Transitor Colpitt's oxillator and its equivalent circuit. Also set the three autonomous differential equation.

Or

(b) Write the state equation for linear resonant RLC circuit and construct the exact solutions of the system.

14. (a) Explain briefly the construction of sierpinski triangle.

Or

(b) Explain the construction and properties of Koch curve.

15. (a) Write down the properties of solitions.

Or

(b) Obtain the general solution of the wave equation $\frac{1}{e^2}\frac{\partial^2 u}{\partial t^2}-\frac{\partial^2 u}{\partial x^2}=0$ where $c^2=\frac{k\alpha^2}{m}$ subject to the initial condition $u(x,t)=\eta(x=n_\alpha t)$.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Distinguish and explain linear system and nonlinear system with specific examples.

Or

(b) Obtain the frequency response relations and draw the primary resonance curves for

$$\ddot{x} + \alpha \dot{x} + w_0^2 x + \beta x^3 = f \sin w t$$

17. (a) Outline the fixed point stability analysis of the damped oscillator $\ddot{x} + 2b\dot{x} + w_0^2 x = 0$ where $2b$ is the damping coefficient.

Or

(b) Describe Pitchfork Bifurcation and also explain super critical and subcritical bifurcation diagrams.

18. (a) Discuss the nonautonomus MLC circuit with neat schematic diagram and carry out the stability analysis.

Or

(b) Draw and study the dynamics of the nonlinear circuit having Chua's diode.

19. (a) Explain the construction and properties of :

(i) Julia set and Madelbrot set fractals.

(ii) Also write the applications of Fractals.

Or

(b) What is meant by Multifractals? Explain how multifractal is constructed and characterized.

20. (a) Starting from Kdv equation, explain the solitary and enoidal waves.

Or

(b) Explain the numerical experiment of zobusky and krushal.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6387 **Sub. Code : ZPHM 21**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Second Semester

Physics – Core

MATHEMATICAL PHYSICS – II

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. For symmetric matrix A^T is equal to
   (a) A (b) $-A$
   (c) $-A^T$ (d) None

2. The eigen values of matrix $\begin{bmatrix} \cos\theta & -\sin\theta \\ -\sin\theta & -\cos\theta \end{bmatrix}$ are
   (a) 1, 1 (b) 1, –1
   (c) –1, –1 (d) 1, 0

3. The only function that is analytic from the following is

(a) $f(z) = \bar{z}$ (b) $f(z) = \mathrm{Im}(z)$

(c) $f(z) = \sin z$ (d) $f(z) = \mathrm{Re}(iz)$

4. The residue of function can be found if the pole is an isolated singularity

(a) True (b) False

(c) No residue at all (d) None of the above

5. The value of $H_1(x)$ is

(a) x (b) $-x$

(c) $2x$ (d) $-2x$

6. Bessel equation of order zero is

(a) $x^2 \frac{d^2y}{dx^2} + \frac{dy}{dx} + xy = 0$

(b) $x^2 \frac{d^2y}{dx^2} + \frac{dy}{dx} - xy = 0$

(c) $x \frac{d^2y}{dx^2} + \frac{dy}{dx} + xy = 0$

(d) $x \frac{d^2y}{dx^2} + \frac{dy}{dx} - xy = 0$

7. Fourier sine transform of $\frac{1}{x}$ is

(a) K (b) K^2

(c) $\frac{K^2}{2}$ (d) $\frac{K^2}{4}$

8. If Laplace transform of $f(t)$ is $F(s)$ then Laplace transform of $\left[e^{-at} f(t)\right]$ is

(a) $f(s-a)$ (b) $f(s+a)$

(c) $f(s)$ (d) None

9. A group of order 3 is always ————————.

(a) factor group

(b) point group

(c) abelian group

(d) none

10. In a group of matrices, all the matrices which belong to ———————— class have same trace.

(a) Different

(b) Same or different

(c) Same

(d) None

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Using Cayley Hamilton theorem find the inverse of the matrix $A = \begin{bmatrix} 5 & 3 \\ 3 & 2 \end{bmatrix}$.

Or

(b) Show that eigen values of a Hermitian matrix are real.

12. (a) State and prove Cauchy's integral theorem.

Or

(b) Find the residue of $f(z) = \dfrac{ze^z}{(z-a)^3}$ at $z = a$.

13. (a) Show that $J_{\frac{1}{2}}(x) = \sqrt{\dfrac{2}{\pi x}} \sin x$.

Or

(b) Derive Rodrigues formula for Hermite polynomial.

14. (a) Find the Fourier transform of $e^{-a^2x^2}$, $a < 0$.

Or

(b) Find the inverse Laplace transform of $\frac{4s+5}{(s-1)^2(s+2)}$.

15. (a) Prove that two right cosets (or left cosets) of a subgroup in a given group are either equal or else have no elements in common.

Or

(b) Define isomorphic and homomorphic groups. Differentiate between them with example.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Find the eigen values and eigen vector of matrix $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$.

Or

(b) If $A = \frac{1}{3}\begin{bmatrix} 1 & 2 & a \\ 2 & 1 & b \\ 2 & -2 & c \end{bmatrix}$ is orthogonal, find a, b, c and A^{-1}.

17. (a) Derive Cauchy's Riemann equations for analyticity.

Or

(b) By integrating around a unit circle evaluate $\int_0^{2\pi} \frac{\cos 3\theta}{5 - 4\cos\theta} d\theta$.

18. (a) Construct power series solution of Hermite differential equation.

Or

(b) Prove that $xJ_n^1(x) = xJ_{n-1}(x) - nJ_n(x)$.

19. (a) Obtain the fourier series for the expansion of $f(x) = x$ in the interval $-\pi \leq x \leq \pi$.

Or

(b) Find the fourier sine and cosine transform for the function $f(x) = 2x \;\; 0 \leq x \leq 4$.

20. (a) State and prove orthogonality theorem.

Or

(b) Construct the symmetry group of a square. Write down its multiplication table, classes and subgroups.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6388 **Sub. Code : ZPHM 22**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022

Second Semester

Physics

Core – ELECTROMAGNETIC THEORY

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Poisson's equation reduces to Laplace equation when

   (a) $v = 0$ (b) $\rho = 0$

   (c) $A = 0$ (d) $\nabla = 0$

2. The induced dipolemoment is approximately proportional to

   (a) Potential (b) Charge

   (c) Field (d) Capacitance

3. ——————law is $F_{mag} = Q(\vec{V} \times \vec{B})$

(a) Biot-Savart (b) Faraday

(c) Ampere circuital (d) Lorentz force

4. In magnetostatics, the continuity equation becomes

(a) $\nabla.\vec{J} + \frac{\partial \vec{\rho}}{\partial t} = 0$ (b) $\nabla.\vec{J} - \frac{\partial \vec{\rho}}{\partial t} = 0$

(c) $\nabla.\vec{J} = 0$ (d) None

5. Neumann formula is not useful for practical calculations but it reveals about ——————

(a) Self inductance (b) Mutual inductance

(c) Capacitance (d) None

6. The Maxwells equation $\nabla.\vec{B} = 0$ implies ————

(a) there exists isolated magnetic pole

(b) the minimum possible structure is a magnetic case is a dipole

(c) there is no magnetic monopoles

(d) North pole and south pole don't exists together

7. If E_Z = ——————, we call these transverse electric waves

(a) ∞ (b) 1

(c) 0 (d) $-\infty$

8. If the medium is linear and Homogeneous the Maxwells equation reduced to

(a) $\nabla.\vec{D} = 0$ (b) $\nabla.\vec{D} = \rho$

(c) $\nabla.\vec{E} = \rho$ (d) $\nabla.\vec{E} = 0$

9. Static sources don't radiate

(a) True

(b) False

(c) Neither true nor false

(d) None

10. A choice of ————————that satisfies the Lorentz condition is called Lorentz Gauge

(a) field (b) potential

(c) field and potential (d) Flux

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Derive an expression for electric field for

(i) Several point charges $q_1 q_2$ and

(ii) Charge is distributed continuously over some region and deduce coloumbs law.

Or

(b) Derive an expression for the workdone to move a point charge.

12. (a) State Biot savart law. Using Biot Savart law, find the magnetic field at a distance Z above the center of a circular loop.

Or

(b) State the integral form of Amperes law. Find the magnetic field at a distance "S" from a long straight wire carrying a steady current I.

13. (a) Explain Faraday Law in the differential and integral forms.

Or

(b) Derive Neumann formula by considering two loops of wire at rest.

14. (a) What is coaxial line? How does electromagnetic wave propagate in it?

Or

(b) Discuss the phenomenon of Reflection at a conducting surface.

15. (a) Derive an expression for power radiated by a point charge.

Or

(b) Differentiate coloumb Gauge and Lorentz Gauge.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) State and prove Gauss Law. Write and explain any one of the applications of Gauss law.

Or

(b) (i) State and prove uniqueness theorem.

(ii) Solve Laplace equation in rectangular coordinates

17. (a) Explain Ampere's law in magnetized materials.

Or

(b) Discuss the effect of a magnetic field on atomic orbits.

18. (a) Obtain Maxwell's equations both differential and integral forms.

Or

(b) State and prove poyntings theorem. Also derive differential form of poynting theorem.

19. (a) Discuss in detail TE wave in rectangular wave guide.

Or

(b) Discuss the propagation of electromagnetic waves in conducting media. Obtain the dispersion relation. Also explain skin depth.

20. (a) Calculate the retarded potentials $V(r,t)$ and $A(r,t)$ of a point charge q moving on a specified trajectory.

Or

(b) Derive an expression for power radiated by point charge and deduce Larmor formula and Lienard's generalization of Lorentz formula.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6389 **Sub. Code : ZPHM 23**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Second Semester

Physics – Core

MICROPROCESSOR 8085 AND
MICROCONTROLLER 8051

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The 8085 requires a minimum operating voltage of
   (a) 4.75V
   (b) 5.75V
   (c) 10V
   (d) 12V

2. The 8085 puts the RD signal to ———————— indicating a READ operation

(a) Zero (b) Low

(c) High (d) None

3. The instructions using ———————— addressing mode have no operands

(a) Direct (b) Register

(c) Register indirect (d) Implied

4. The 8085 instructions are ———————— bytes long

(a) 1 to 2 (b) 1 to 3

(c) 1 to 4 (d) 1 to 5

5. ———————— is a programmable 4 – channel direct memory access controller

(a) 8212 (b) 8253

(c) 8257 (d) 8254

6. In 8253 PIT, the tuner can be operated in ———————— different operating modes

(a) seven (b) six

(c) five (d) four

7. Intel 8051 operates with ———————— clock and a single +5V power supply.

(a) 12 GHZ

(b) 12 KHZ

(c) 12 MHZ

(d) None

8. In 8051 takes ———————— for multiplication and division

(a) 4 μ s (b) 4 m s

(c) 4 n s (d) None

9. Sample hold circuit is an ———————— device

(a) Digital

(b) Analog

(c) Neither digital nor analog

(d) None

10. The square wave can be generated using ———————— line of the micro processor.

(a) POP

(b) SOP

(c) SOD

(d) None

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Explain available status flags in Intel 8085.

Or

(b) What do you mean by interrupt? Explain.

12. (a) Write an assembly language program to find one's complement of 96H.

Or

(b) Draw and explain the timing diagram for memory read operation.

13. (a) Explain the interfacing of Intel 8212 in input mode output mode.

Or

(b) Write short notes on address space portioning.

14. (a) Explain the features of 8051micro controller and compare it with 8085 μp .

Or

(b) What is P S W in an 8051? How is stack implemented in 8051?

15. (a) Explain how Ramp wave generated using micro processor.

Or

(b) Explain with suitable diagram how a seven segment display in interfaced with a micro processor.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Sketch the architecture of 8085 μp and explain the various control signals available in processor.

Or

(b) With a suitable diagram explain the various registers and flags available and their uses in 8085 μp .

17. (a) Explain Branch group instructions and logical instructions in 8085 μp .

Or

(b) What are the addressing modes of 8085 μp and explain with example.

18. (a) Draw the pin configuration of 8255 A PPI and explain its operation.

Or

(b) Give the functional block diagram of DMA controller 8257 and explain the function of internal register of 8257.

19. (a) Explain the special function registers of 8051.

Or

(b) Draw the pin diagram of 8051 micro controller and explain the function of each pin.

20. (a) Explain the technique involved in the interfacing of key board with 8085 μp with a neat diagram.

Or

(b) What is a stepper motor? Show the interface connection for a microprocessor based scheme for controlling stepper motor.

———————

(6 pages) **Reg. No. :** .....

Code No. : 6390 **Sub. Code : ZPHM 24**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Second Semester

Physics – Core

STATISTICAL MECHANICS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. An ensemble in which both energy and the number of particles can be exchanged with the heat reservoir is known as _____ ensemble.

   (a) Microcanonical

   (b) Grand canonical

   (c) Neither micro or Grand canonical

   (d) None

2. The maximum volume of a cell in phase space is of the order of

(a) h (b) $\hbar$

(c) $\hbar^2$ (d) h^3

3. The statistical entropy σ and thermodynamical entropy s are related by

(a) $s = k\sigma$ (b) $s = h\sigma$

(c) $s = T\sigma$ (d) $s = \rho k\sigma$

4. Identical but distinguishable particles obey

(a) Maxwells-Boltzman distribution law

(b) Bose Einstein statistics

(c) Fermi Dirac statistics

(d) None

5. _____ is known as Bosons.

(a) Eectron (b) Proton

(c) Neutron (d) Particle

6. Physical quantities in classical mechanism in general are assumed to have

(a) continous

(b) discrete

(c) neither continous nor discrete

(d) none

7. The fermic energy of Lithium is 7.4×10^{-17} J. Its Fermi temperature is

(a) 53262°C (b) 5326 K

(c) 53262 K (d) 532.6°C

8. At Bose temperature T_b, chemical potential μ value is _____.

(a) zero (b) one

(c) two (d) infinity

9. The transaction from nonferromagnetic state to the ferro magnetic state called the phase transition of _____ kind is associated with some kind of change in the symmetry of the lattice.

(a) zero (b) first

(c) second (d) third

10. Using Thermoelectric thermometers with copper-constant an thermocouple temperature upto _____ can be measured.

(a) 250°C (b) 2500°C

(c) – 250°C (d) – 2500°C

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Explain what are microcanonical and canonical ensembles.

Or

(b) Derive the relation $\rho = \exp.\left(\frac{e_1 - E}{k}\right)$, using the idea of ensemble.

12. (a) Write short notes on

(i) stirling's approximation and

(ii) thermodynamical probability

Or

(b) Explain Maxwell's distribution for molecules of more than a single kind.

13. (a) Write two important facts that influenced the transaction from classical statistical mechanics to quantum mechanics.

Or

(b) Explain how symmetric and antisymmetric wave functions are constructed for two and three particle system.

14. (a) Discuss the Bose Einstein condensation in the high density limit at a fixed temperature as "V" reduced.

Or

(b) Obtain expression for specific heat of the electron.

15. (a) Explain briefly magnetic caloric effect.

Or

(b) Discuss the Ising model for phase transaction of second kind.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b)

16. (a) State and prove Leoville's theorem in statistical mechanics.

Or

(b) Establish the connection between statistical and thermodynamic quantities. Derive expressions for chemical potential, free energy and Gibbs tree energy.

17. (a) State and prove the law of equipartition of energy.

Or

(b) Derive Boltzman entropy relation.

18. (a) Discuss the theory of blackbody radiation and deduce stefan Boltzman Law.

Or

(b) Discuss the theory of Maxwell Boltzmann statistics and deduce expression for distribution function.

19. (a) Explain Einstein theory of specific heat of solids. Also write the drawback of Einstein theory.

Or

(b) Apply Bose Einstein statistics to Boson gas. Explain Bose Einstein condensation.

20. (a) Explain with the help of necessary theory, how extremely low temperature can be produced in the Laboratory.

Or

(b) Discuss

(i) Magnetic thermometer and

(ii) Gas thermometers for the measurement of low temperatures.

———————

(7 pages) **Reg. No. :** .....

Code No. : 6391 **Sub. Code : ZPHM 31**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics — Core

QUANTUM MECHANICS — I

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — ($10 \times 1 = 10$ marks)

Answer ALL questions.

Choose the correct answer :

1. The value of probability density will be

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{2}$

(c) $\frac{1}{2^2}$ (d) $(1/2)^2$

2. To solve schrodinger equation we need potential and

   (a) physical requirements of system

   (b) boundary condition

   (c) none of these

   (d) both (a) and (b)

3. The energy Spectra of bound state are

   (a) Continuous (b) Discrete

   (c) Degenerate (d) Non Degenerate

4. Bound State Occur when particle can not move to

   (a) Infinity (b) Maximum

   (c) Zero (d) Minimum

5. The eigen function of a degenerate spectrum is an even potential do not have

   (a) odd parity (b) even parity

   (c) definite parity (d) none

6. If the PE is even the Hamilton will be

   (a) odd

   (b) even

   (c) neither even nor odd

   (d) none

7. If L is angular momentum operator then

(a) $L \times L = 0$ (b) $L\_L = L_z$

(c) $L \times L = iLh/2\pi$ (d) $L\_(L \times L) = 0$

8. If L is angular momentum operator and L_z is its z-component, then

(a) $[L, L_z] = 0$ (b) $[L^2, Lz] = 0$

(c) $[L^2, L_z] = h$ (d) $[L^2, Lz] = 1$

9. In the Stark effect if first excited state of hydrogen atom, the degeneracy is

(a) Completely removes

(b) Not remove at all

(c) Partially removes

(d) Four folds

10. The Process which is not allowed is

(a) Spontaneous emission

(b) Spontaneous absorption

(c) Induced absorption

(d) Induced emission

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) An electron has a speed of 5.00 m/s with an accuracy of 0.004 % calculate the certainty with which we can locate the position of the electron.

Or

(b) How classical physics failed to account for the spectral distribution of energy density in a black body?

12. (a) Formulate schroedingers for a rigid rotator. Find its eigen values and eigen functions.

Or

(b) Determine the energy levels of a linear harmonic oscillator on the basis of the schroedinger's equation.

13. (a) If A and B are constants of motion and H is the Hamiltonian, then show that [A,B] is also a constant of motion.

Or

(b) Define Hilbert space and illustrate its significance in the study of quantum mechanics.

14. (a) If the angular momentum operators obey the rule $[J_x, J_y] = i\hbar\, j_z$ and similar commutation relations for the other components, evaluate the commutators $[J^2, J_x]$ and $[J^2, J_+]$. What would be the roles of J_+ and J_- in the new situation?

Or

(b) Derive the eigen value of operator J^2 and J_z where J^2 and J_z represent the square and the Z-component of the angular momentum operator.

15. (a) Give an account of adiabatic approximation.

Or

(b) Which of the following transitions are electric dipole allowed?

(i) $1s \rightarrow 2s$

(ii) $1s \rightarrow 2p$

(iii) $2p \rightarrow 3d$

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) Anucileus is confined to nucleus of radius 5×10^{-15} meters. Calculate the minimum uncertainty in the momentum of the nucleon. Also calculate the minimum kinetic energy of the nucleon.

Or

(b) Derive time dependent and independent schrodinger wave equations.

17. (a) Write down radial wave function for hydrogen atom and solve it to obtain the expression for bound state.

Or

(b) Calculate the discrete energy levels of a particle in one dimensional square well potential with perfectly rigid walls.

18. (a) Does taking the complex conjugate correspond to
(i) a linear operator
(ii) a Hermitian operator
(iii) an operator which is its own complex conjugate?

Or

(b) Give the matrix theory of the linear harmonic oscillator.

19. (a) Calculate C-G coefficient for $j_1 = 1$ and $j_2 = 1/2$.

Or

(b) Find the angular momentum matrices for j = 1 for the operator $< J'm' | J^2 | Jm >$ and $< J'm' | J_Z | J_m >$.

20. (a) What do you mean by perturbation theory? Discuss the perturbation theory for non-degerate levels in first and second orders.

Or

(b) Derive Fermi-Golden rule for constant perturbation that acts for a short interval of time.

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(6 pages)

Reg. No. : .....

Code No. : 6392 **Sub. Code : ZPHM 32**

M.Sc.(CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics

ATOMIC AND MOLECULAR SPECTROSCOPY

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Find the true statement

   (a) An electron will not lose energy when jumping from the 1st orbit to the 3rd orbit

   (b) An electron will not give energy when jumping from the 1st orbit to the 3rd orbit

   (c) An electron will release energy when jumping from the 1st orbit to the 3rd orbit

   (d) An electron will absorb energy when jumping from the 1st orbit to the 3rd orbit

2. Calculate the ratio of the kinetic energy for the n = 2 electron for the Li atom to that of Be^+ ion

(a) 9/16 (b) 3/4

(c) 1 (d) ½

3. Zeeman effect is the splitting of spectral line in the presence of ————————

(a) Electric Field (b) Magnetic Field

(c) Inert Environment (d) Vacuum

4. Zeeman Effect could not be proved by

(a) Quantum Mechanics

(b) Bohr's Model

(c) Hamiltonian operators

(d) L-S coupling

5. The spectra caused in the infrared region by the transition in vibrational levels in different modes of vibrations are called

(a) Rotational spectra

(b) Electronic spectra

(c) Vibrational spectra

(d) None of these

6. The IR spectra of a compound helps in
   (a) Proving the identity of compounds
   (b) Showing the presence of certain functional groups in the molecule
   (c) Neither of the above
   (d) Both of the above

7. Which of the following is not a type of NMR spectrometer?
   (a) Minimal type (b) Maximal type
   (c) Multipurpose type (d) Wideline type

8. Which of the following NMR spectrometers have stressed reliability and ease of operation?
   (a) Minimal type (b) Maximal type
   (c) Multipurpose type (d) Wideline type

9. The elastic scattering of photons is called as
   (a) Atmospheric scattering
   (b) Rayleigh Scattering
   (c) Conserved Scattering
   (d) Raman Scattering

10. Which of the following cannot be conserved during Raman scattering?
   (a) Total Energy (b) Momentum
   (c) Kinetic Energy (d) Electronic Energy

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) For the $^2D_{5/2}$ state of the electron calculate the possible values of m_j and J_z.

Or

(b) Discuss in detail forbidden transitions and selection rules.

12. (a) Explain the normal Zeeman effect.

Or

(b) With a neat diagram explain the magnetic moment of the atom and 'g' factor.

13. (a) What is the change in the rotational constant B when hydrogen is replaced by deuterium in the hydrogen molecule?

Or

(b) Explain about basic principles of ESR.

14. (a) What is the nuclear g_N factor for ^{19}F nucleus which has a magnetic moment of 2.6273 μ_N nuclear spin quantum number I = 1/2.

Or

(b) Explain the magnetic properties of nuclei.

15. (a) Give the classical theory of Raman effect.

Or

(b) Distinguish between spontaneous and stimulated emission.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) A beam of silver atoms in a stern. Gerlach experiment obtained from an over heated to a temperature of 150k passes through an in homogeneous magnetic field having a field gradient of 20,000 gauss/cm (2×10^4 gauss = 2wb/m^2/ perpendicular to the beam. The pole faces are 10 cm long. What is the separation between the two components of the beam at the end of the magnet?

Or

(b) Describe the stem and Gerlach experiment and indicate the importance of the results.

17. (a) State and explain the Paschen Back effect.

Or

(b) With a neat diagram explain the normal stark effect.

18. (a) The fundamental band for Hcl is central at 2886 cm^{-1} Assuming that the internuclear distance is 1.276A° calculate the wave number of the first two lines of each of the P and R branches of Hcl.

Or

(b) Explain in detail vibrating diatomic molecules.

19. (a) A particular NMR instrument operates at 30.256 MHz. What magnetic fields are required to bring a proton nucleus and 13_c nucleus to resonance at this frequency? Magnetic moment of proton= 2.7927 μ_N and magnetic moment of $13_c = 0.7022\,\mu_N$.

Or

(b) With a neat block diagram explain the ESR spectrometer.

20. (a) Obtain the rate equations of a two and three level laser.

Or

(b) Describe the rotational Raman spectra for symmetric top molecules.

———————

(6 pages)

Reg. No. : .....

Code No. : 6393 **Sub. Code : ZPHM 33**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics – Core

CONDENSED MATTER PHYSICS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. If a crystal lattice has 6 closed-pack spheres, what the number of tetrahedral voids in the lattice?

   (a) 12 (b) 6

   (c) 36 (d) 3

2. Which of the following possess anisotropic nature within their structure?

   (a) Hair wax (b) Snowflakes

   (c) Polythene (d) Crystal glass

3. Consider a one-dimensional solid with a lattice spacing of 0.32 nm. What is the value for the wavevector k at the zone boundary of the first Brillouin zone?

(a) 8.17 nm^{-1} (b) 9.82 nm^{-1}

(c) 10.43 nm^{-1} (d) 21.63 nm^{-1}

4. Which of the experimental methods below is the best choice for determining phonon dispersion curves?

(a) Inelastic neutron scattering
(b) Transmission electron microscopy
(c) X-ray diffraction
(d) Scanning tunnel microscopy

5. When the temperature of either n-type or p-type increases, determine the movement of the position of the Fermi energy level?

(a) Towards up of energy gap
(b) Towards down of energy gap
(c) Towards center of energy gap
(d) Towards out of page

6. Consider a bar of silicon having carrier concentration n0 = 1015 cm^{-3} and ni = 1010 cm^{-3}. Assume the excess carrier concentrations to be n = 1013 cm^{-3}, calculate the quasi - fermi energy level at T = 300K?

(a) 0.2982 eV (b) 0.2984 eV

(c) 0.5971 eV (d) 1 Ev

7. The temperature below which certain materials are antiferromagnetic and above which they are paramagnetic is called

(a) Weiss temperature (b) Curie temperature

(c) Neel temperature (d) None of the above

8. In a piezoelectric crystal, the application of mechanical force will cause

(a) Plastic deformation of crystal

(b) Magnetic dipoles in the crystal

(c) Electrical polarization in the crystal

(d) Shift in Fermi level

9. There are three important lengths which enter the theory of superconductivity except

(a) London penetration length

(b) Intrinsic coherence length

(c) Normal electron mean free length

(d) Mean path length

10. The phenomena of superconductivity was first discovered by ————

(a) Kammerlingh Onnes

(b) Richard Smalley

(c) Otto Lehman

(d) Neils Bohr

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) For a certain BCC crystal the (110) plane has a separation of 1.1817 A°. These planes are indicated with X-rays of wavelength 1.540 A°. How many order of Bragg's reflections can be observed in this case?

Or

(b) Discuss in detail Fourier analysis of the basis.

12. (a) Explain the umklapp processes.

Or

(b) Explain the Debye model for density of states.

13. (a) Evaluate the value of Fermi distribution function for an energy KT above the Fermi energy at that temperature and give some comments on your answer.

Or

(b) Explain free electron gas in three dimensions.

14. (a) Dy^{3+} has outer electronic configuration of $4f^9 6s^0$. Calculate the magnetic susceptibility for a salt containing one kg mole of Dy^{3+} ions at 300 k.

Or

(b) Explain the nuclear magnetic resonance.

15. (a) Explain the dielectric constant and polarizability.

Or

(b) Explain the concept of SQUID.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b)

16. (a) An x-ray tube operates at a potential difference of 24800 v and has a copper target. The first order glancing angle for NaCl crystal for Kα line at $\lambda = 1.54$ A° is 15.8°. Calculate (i) the grating spacing for NaCl crystal and (ii) the glancing angle for minimum wavelength of the continuous spectrum.

Or

(b) Discuss in detail analysis of elastic strains.

17. (a) Describe the Einstein model of lattice heat capacity. Discuss the success and failures of this model.

Or

(b) Explain the thermal resistivity of phonon gas.

18. (a) The Hall coefficient of a certain silicon specimen was found to be $-7.35 \times 10^{-5} m^3 c^{-1}$ from 100 to 400 k. Determine the nature of the semiconductor. If the conductivity was found to be 200 $m^{-1} \Omega^{-1}$, calculate the density and mobility of the charge carrier.

Or

(b) Explain the DeHass - Van Alphen effect.

19. (a) A paramagnetic material has bcc structure with a cube edge of 2.5 A°. If the saturation value of magnetization is 1.8×10^6 Am^{-1}. Calculate the average magnetization contributed per atom in Bohr magnetons.

Or

(b) Explain quantum theory of paramagnetism.

20. (a) Derive the London equations and explain the term coherence length.

Or

(b) Discuss d.c. and a.c. Josephson's effects and explain their importance.

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(7 pages)

` **Reg. No. :** .....

Code No. : 6394 **Sub. Code : ZPHM 34**

M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics — Core

NUMERICAL METHODS AND PROGRAMMING
IN C++

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Numerical techniques more commonly involve _____

(a) Elimination method

(b) Reduction method

(c) Iterative method

(d) Direct method

2. Which of the following is the advantage of using the Gauss Jordan method?

(a) Additional calculations

(b) No labour of back substitution

(c) More operations involved

(d) Elimination is easier

3. To get a curve of best fit the sum of squares of residuals should be

(a) maximum (b) minimum

(c) infinity (d) none of the above

4. In cubic spline, the condition for natural spline is given by ————————

(a) $M_0 = M_{n-1}$ (b) $M_0 = M_n = M_{n+1}$

(c) $M_0 = M_n = 0$ (d) $M_n = 2M_{n+1}$

5. The order of the error for the trapezoidal method is

(a) h (b) h^2

(c) h^3 (d) h^4

6. Evaluation of integral using Monte - Carlo method requires

(a) Variables (b) Constants

(c) Random numbers (d) None of the above

7. If conditions are specified at two or more points, then it is called a ———— value problem.

(a) finite (b) boundary

(c) initial (d) infinite

8. Given $\frac{dy}{dx} + x = 0$, $y(0) = 0$ the value of $y(1)$ using Euler's method in single step is

(a) 0 (b) +1

(c) –1 (d) 2

9. What is the insertion operator on C++?

(a) << (b) >>

(c) > (d) <

10. Given Cauchy's constant $A = 1.5$ and $B = 1.5 \times 10^{-14}$, the refractive index corresponding to 6000 A° is

(a) 1.6 (b) 1.5041

(c) 1.7041 (d) None of the above

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

11. (a) Find a real root of the equation $x^3 - 2x - 5 = 0$.

Or

(b) Find a real root of $f(x) = x^3 + x^2 + x + 7 = 0$ correct to three decimal places.

12. (a) Using Lagrange's interpolation formula, find the form of the function $y(x)$ from the following table.

x	y
0	–12
1	0
3	12
4	24

Or

(b) Differentiate between the forward difference and backward difference in interpolation.

13. (a) Using Simpson's $\frac{1}{3}$-rule with $h = 1$, evaluate the integral $I = \int_3^7 x^2 \log x dx$.

Or

(b) Estimate the value of the integral $I = \int_0^{1/2} \frac{dx}{\sqrt{x}\sqrt{1-x}}$ using the trapezoidal rule. What is its exact value?

14. (a) From the Taylor series for $y(x)$ find $y(0.1)$ correct to four decimal places if $y(x)$ satisfies $y' = x - y^2$ and $y(0) = 1$.

Or

(b) Write down the Jacobi's method with solution of Laplace's equation.

15. (a) Bring out the concept of header files in C++ programming.

Or

(b) Mention the least square method using linear fitting.

PART C — ($5 \times 8 = 40$ marks)

Answer ALL questions, choosing either (a) or (b)
Each answer should not exceed 600 words.

16. (a) Find a root, correct to three decimal places and lying between 0 and 0.5, of the equation $4e^{-x} \sin x - 1 = 0$.

Or

(b) Find a real root of the equation $x = e^{-x}$, using the Newton-Raphson method.

17. (a) The table below gives the values of $\tan x$ for $0.10 \le x \le 0.30$.

x	$y = \tan x$
0.10	0.1003
0.15	0.1511
0.20	0.2027
0.25	0.2553
0.3	0.3093

Find : tan 0.12.

Or

(b) Certain corresponding values of x and $\log_{10} x$ are (300, 2.4771), (304, 2.4829), (305, 2.4843) and (307, 2.4871) Find $\log_{10} 301$.

18. (a) Calculate the first and second derivatives of the function tabulated in the preceding example at the point $x = 2.2$ and also dy/dx at $x = 2.0$.

x	y	x	y
1.0	2.7183	1.8	6.0496
1.2	3.3201	2.0	7.3891
1.4	4.0552	2.2	9.0250
1.6	4.9530		

Or

(b) Derive Simpson's $\frac{3}{8}$-rule.

$\int_{x_0}^{x_3} y\,dx = \frac{3}{8}h(y_0 + 3y_1 + 3y_2 + y_3)$ using this rule, evaluate $\int_0^1 \frac{1}{1+x}\,dx$ with $h = \frac{1}{6}$. Evaluate the integral by Simpson's $\frac{1}{3}$ - rule and compare the results.

19. (a) Give the differential equation $\frac{dy}{dx} = x^2 + y$ with $y(0) = 1$, compute $y(0.02)$ using Euler's modified method.

Or

(b) Explain the Successive Over Relaxation (SOR) method with solution of Laplace's equation.

20. (a) Compare the local and global variables in C++ programming with example.

Or

(b) Write a C++ program to evaluate the currents in Wheatstone's bride using Gauss elimination method.

———————