R4562

Sub. Code
25MPH2C1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Physics

QUANTUM MECHANICS – I

(CBCS – 2025 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The commutator $[\hat{x}, \hat{p}]$ is equal to (CO1, K1)

   (a) 0 (b) $i\hbar$

   (c) $-i\hbar$ (d) $\hbar^2$

2. The physical meaning of $|\psi(x,t)|^2$ is (CO1, K2)

   (a) energy density

   (b) probability density

   (c) momentum density

   (d) current density

3. Energy levels of a particle in a one-dimensional infinite potential well (width L) are (CO2, K1)

   (a) $E_n = n^2\pi^2\hbar^2 / (2mL^2)$

   (b) $E_n = n\hbar^2 / (2mL^2)$

   (c) $E_n = n^2\hbar^2 / (8mL^2)$

   (d) $E_n = n\pi^2\hbar^2 / (mL^2)$

4. The phenomenon of quantum tunneling is used to explain (CO2, K2)

(a) Photoelectric effect

(b) α-decay of radioactive nuclei

(c) Compton scattering

(d) Black body radiation

5. In Dirac notation, the orthonormality condition is written as (CO3, K1)

(a) $\langle n \mid m \rangle = \delta_{ij}$ (b) $\langle n \mid m \rangle = 1$

(c) $\langle n \mid m \rangle = n + m$ (d) $\langle n \mid m \rangle = 0$

6. For the quantum harmonic oscillator, the action of the lowering operator $\hat{a}$ on state $| n \rangle$ gives (CO3, K2)

(a) $\sqrt{n}|n-1\rangle$ (b) $\sqrt{n+1}|n+1\rangle$

(c) $n \mid n\rangle$ (d) 0

7. The first-order energy correction in non-degenerate time-independent perturbation theory is (CO4, K1)

(a) $\langle n \mid H' \mid n \rangle$ (b) $\sum_{m \neq n} \frac{|< m|H^I|n >|^2}{(E_n - E_m)}$

(c) $\langle n \mid H \mid n \rangle$ (d) 0

8. The approximate ground state energy of the helium atom is usually calculated using (CO4, K2)

(a) WKB approximation

(b) Variation method

(c) Exact analytical solution

(d) Degenerate perturbation theory

9. Fermi's golden rule for the transition rate is proportional to (CO5, K2)

(a) $|\langle f \mid H' \mid i \rangle|^2$ (b) $|\langle f \mid H' \mid i \rangle|$

(c) $(E_f - E_i)$ (d) time t only

10. Einstein's B coefficient is associated with (CO5, K2)

(a) Spontaneous emission

(b) Stimulated emission

(c) Absorption only

(d) Rayleigh scattering

Part B ($5 \times 5 = 25$)

Answer **all** questions not more than 500 words each.

11. (a) Write and explain the four main postulates of quantum mechanics with one simple example each. (CO1, K4)

Or

(b) Write the time-independent Schrödinger equation. Explain what is meant by stationary states and their important properties. (CO1, K5)

12. (a) Derive the energy eigenvalues and wave functions for a particle in a one-dimensional infinite square well $(0 < x < L)$. (CO2, K3)

Or

(b) Explain the concept of quantum mechanical tunneling. Draw a simple rectangular potential barrier and mention its application in α-decay. (CO2, K5)

13. (a) What is meant by Hilbert space in quantum mechanics? Explain Dirac's bra $\langle$*and ket*$|\rangle$ notation with the orthonormality condition. (CO3, K4)

Or

(b) Using ladder operators, solve the one-dimensional quantum harmonic oscillator problem and write the energy eigenvalues. (CO3, K5)

14. (a) Explain non-degenerate time-independent perturbation theory. Write the formula for the first-order correction to the energy. (CO4, K4)

Or

(b) Describe the variation method in quantum mechanics. Explain how it is used to estimate the ground state energy of the helium atom. (CO4, K5)

15. (a) State Fermi's golden rule. Explain its meaning and write the expression for transition probability per unit time. (CO5, K5)

Or

(b) What are Einstein's A and B coefficients? Explain the relation between spontaneous emission and stimulated emission. (CO5, K4)

Part C ($5 \times 8 = 40$)

Answer **all** questions not more than 1000 words each.

16. (a) Explain Heisenberg's uncertainty principle in detail. Derive the position-momentum uncertainty relation $\Delta x \Delta p \geq \hbar / 2$ using the Commutator. Give two simple examples. (CO1, K1)

Or

(b) State Ehrenfest's theorem. Derive the time evolution equations for the expectation values $\langle x \rangle$ and $\langle p \rangle$ and show how they resemble classical equations. (CO1, K6)

17. (a) Solve the Schrödinger equation for the hydrogen atom in three dimensions. Write the energy levels and explain the quantum numbers $n, 1, m$.(CO2, K5)

Or

(b) Explain the quantum mechanical treatment of the rigid rotator. Derive the rotational energy levels and discuss its application to diatomic molecules. (CO2, K6)

18. (a) Compare and contrast the Schrödinger picture, Heisenberg picture, and interaction picture. Write the basic time-evolution equations in each picture. (CO3, K4)

Or

(b) Explain how the one-dimensional harmonic oscillator is solved in matrix representation. Show that the energy levels are $E_n = \hbar\omega(n + 1/2)$. (CO3, K5)

19. (a) Describe the WKB (semi-classical) approximation method. Derive the Bohr-Sommerfeld quantization rule and apply it to obtain approximate energy levels of the harmonic oscillator. (CO4, K4)

Or

(b) Explain degenerate perturbation theory with an example. Discuss how it is applied to understand the linear Stark effect in the hydrogen atom. (CO4, K6)

20. (a) Derive the expression for transition probability under a time-dependent harmonic (periodic) perturbation. Explain the condition for resonance. (CO5, K5)

Or

(b) Discuss spontaneous emission and stimulated emission. Explain how Einstein's A and B coefficients are related and describe the basic principle of laser action. (CO5, K5)

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R4563

Sub. Code
25MPH2C2

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Physics

MATHEMATICAL PHYSICS – II

(CBCS – 2025 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective questions by choosing the correct option.

1. Which of the following is not an analytic functions? (CO1, K1)

   (a) z^2 (b) e^z

   (c) $\bar{z}$ (d) $\sin z$

2. If a function has a pole of order one at $z = a$, then the pole is called (CO1, K2)

   (a) Essential singularity

   (b) Removable singularity

   (c) Simple pole

   (d) Higher order pole

3. The wave equation is (CO2, K1)

(a) elliptic (b) parabolic

(c) hyperbolie (d) linear algebraic

4. The inner product used in Gram-Schmidh process must satisfy (CO2, K1)

(a) linear only

(b) positive only

(c) conjugate symmetry only

(d) All inner product properties

5. A tensor of rank zero is (CO2, K1)

(a) vector (b) scalar

(c) matrix (d) dyadic

6. The metric tensor is used to (CO3 K1)

(a) define coordinate transformations

(b) measure distance and angle

(c) define curvature only

(d) convert vectors to scalars

7. If $P(A)=0.4$, then $P(A')$ is (CO4, K2)

(a) 0.4 (b) 0.6

(c) 1.4 (d) –0.4

8. The probability of the sure event is (CO4, K2)

(a) 0

(b) 1

(c) –1

(d) depends on sample space

9. A group $(G,*)$ must satisfy (CO5, K2)

(a) Closure only

(b) Closure and associatively

(c) Closure, associatively , identity and inverse

(d) Closure and identity

10. Every cyclic group is (CO5, K1)

(a) non-abelian (b) abelian

(c) finite (d) infinite

Part B (5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Check that whether $f(z)=|z|^2$ is analytic or not. (CO2, K3)

Or

(b) Using Cauchy's integral formula, evaluate $\oint \frac{z^2}{z-1} dz$ where $C:|z|=2$. (CO2, K3)

12. (a) Solve the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}; 0 < x < L$ (CO2, K4)

Subject to boundary conditions

$u(0,t) = 0, u(L,t) = 0$.

Or

(b) Solve Laplace's equation in a circular region of radius a using separation of variables. (CO2, K3)

13. (a) Verify whether the quantity $x_i x_j$ forms a tensor under coordinate transformation. (CO3, K3)

Or

(b) Show that any anti symmetric second order tensor in 3-D can be represented by a vector. (CO3, K3)

14. (a) If a random variable follows a binomial distribution with $n = 5, p = 0.4$, find (CO4, K5)

(i) $P(X = 2)$

(ii) $P(X \leq 3)$.

Or

(b) Elucidate the Gauss's normal distribution. (CO4, K5)

15. (a) Discuss the reducible representation. (CO5, K3)

Or

(b) Elucidate the C_{3v} point group. (CO5, K5)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Expand $f(z)=\frac{1}{z-2}$ in a Taylor series about $z=1$. (CO1, K5)

Or

(b) Find the evaluate of the following : (CO1, K5)

(i) $\oint_C \frac{z}{(z-1)(z-2)}dz$ where C encloses both poles.

(ii) $\oint_C \frac{dz}{(z-2)}dz$ where C is the circle $|z|=3$.

17. (a) Solve the wave equation (CO2, K4)

$$\frac{\partial^2 u}{\partial t^2}=c^2\frac{\partial^2 u}{\partial x^2}.$$

Or

(b) Enumerate the Gram Schmidt orthogonalization process. (CO2, K5)

18. (a) Describe the types of tensors. (CO3, K4)

Or

(b) Elucidate the linear product and outer product. (CO3, K5)

19. (a) Explain the binomial distribution. (CO4, K3)

Or

(b) Discuss the Poisson distribution. (CO4, K3)

20. (a) Enumerate the homomorphism and Isomorphism of groups. (CO5, K3)

Or

(b) State and prove orthogonality theorem. (CO5, K3)

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R4564

Sub. Code
25MPH2C3

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Physics

ELECTROMAGNETIC THEORY

(CBCS – 2025 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Gauss's law relates electric flux to (CO1, K1)
   (a) Electric field (b) Charge enclosed
   (c) Potential (d) Current

2. Biot-Savart law gives the magnetic field due to (CO1, K1)
   (a) Moving charge (b) Stationary charge
   (c) Electric dipole (d) Magnetic dipole

3. Skin depth is defined as the depth at which current density becomes (CO2, K1)
   (a) Zero
   (b) Maximum
   (c) $\frac{1}{e}$ of its surface value
   (d) half of its surface value

4. The speed of electromagnetic waves in vacuum is given by (CO2, K2)
   (a) $\sqrt{\mu_0 \varepsilon_0}$ (b) $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$
   (c) $\mu_0 \varepsilon_0$ (d) $\frac{\mu_0}{\varepsilon_0}$

5. The normal component of electric field changes if surface charge density. (CO3, K2)

(a) exists (b) is zero

(c) is negative (d) is infinity

6. The condition for total interval reflection is (CO3, K1)

(a) $i < c$ (b) $i = c$

(c) $i > c$ (d) $i = 0$

7. Clausius – Mossotti relation connects (CO4, K2)

(a) Magnetic susceptibility and permeability

(b) Electric susceptibility and polarisability

(c) Refractive index and wavelength

(d) Conductivity and current

8. Normal dispersion occurs when refractive index (CO4, K2)

(a) increases with wavelength

(b) decreases with wavelength

(c) is independent of wavelength

(d) becomes zero

9. Plasma supports electromagnetic waves only when (CO5, K2)

(a) $w < w_p$ (b) $w = w_p$

(c) $w > w_p$ (d) $w = 0$

10. Pinch effect in plasma is due to (CO5, K1)

(a) Electric field only

(b) Magnetic pressure

(c) Gravitational force

(d) Thermal expansion

Part B (5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Deduce the following (CO1, K3)

    (i) Coulomb's law

    (ii) Energy of a point charge distribution

    Or

    (b) Describe the magnetic scalar potential. (CO1, K3)

12. (a) Elucidate the transverse nature of electromagnetic wave. (CO2, K3)

    Or

    (b) Outline the polarization of electromagnetic waves. (CO2, K3)

13. (a) Briefly explain the reflection and refraction of electromagnetic wave at the interface of non-conducting media. (CO3, K4)

    Or

    (b) Write a short note on Brewter's law and degree polarisation. (CO3, K4)

14. (a) Describe the scattering parameters. (CO4, K3)

    Or

    (b) Explain the coherence and incoherence of scattered light. (CO4, K3)

15. (a) Write a short note on (CO5, K4)

    (i) Conditions for plasma existence.

    (ii) Occurrence of plasma.

    Or

    (b) Discuss the magnetic confinement. (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Explain the magnetic vector potential. (CO1, K3)

Or

(b) Interpret the Farady's law and energy in magnetic field. (CO1, K5)

17. (a) Deduce Maxwell's equation in free space and isotropic media. (CO2, K4)

Or

(b) Discuss the conservation of energy and momentum. (CO2, K4)

18. (a) Obtain Fresnel's equation. (CO3, K4)

Or

(b) Explain the boundary condition at the surface of discontinuity. (CO3, K4)

19. (a) Describe the normal and anomalous dispersion. (CO4, K3)

Or

(b) Derive Clausius – Mossotti relation. (CO4, K3)

20. (a) Explain the charged particles in uniform constant electric field. (CO5, K4)

Or

(b) Discuss the pinch effect and its types. (CO5, K4)

R4565

Sub. Code
25MPH2E2

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Physics

Elective — MATERIALS AND CHARACTERIZATION

(CBCS – 2025 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The temperature at which the rate of crystal growth is maximum is generally (CO1, K1)

   (a) At the melting point

   (b) Just below the melting point

   (c) At room temperature

   (d) Above the boiling point

2. The Bridgeman technique is primarily used for growth from (CO1, K1)

   (a) Solution (b) Vapour

   (c) Melt (d) Gel

3. A OD nanostructure is also known as a (CO2, K1)

   (a) Quantum well (b) Quantum wire

   (c) Quantum dot (d) Nano composite

4. The "Bottom-up" approach includes (CO2, K2)

(a) Ball milling (b) Lithography

(c) Sol-gel (d) Etching

5. Thin film deposition by heating a material in a vacuum is called (CO3, K1)

(a) Sputtering (b) Thermal evaporation

(c) CVD (d) Spray pyrolysis

6. Which techniques measures film thickness using the interference of light? (CO3, K2)

(a) SEM (b) Interferometer

(c) TEM (d) XRD

7. The phenomenological model used in solid-state ionics is (CO4, K1)

(a) Drude (b) Free volume theory

(c) Newton's law (d) Ohm's law

8. SEI is lithium batteries stands for (CO4, K1)

(a) Solid electrolyte Interphase

(b) Surface energy index

(c) Solid entry ion

(d) Selective electrolyte ion

9. The pulse-echo method is a part of (CO5, K2)

(a) Thermography (b) Ultrasonic testing

(c) Liquid penetrant (d) AE

10. Which NDT method used infrared radiation? (CO5, K2)

(a) Liquid penetrant (b) Thermography

(c) Ultrasonics (d) Acoustic emission

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Explain the importance of Mier's T-C diagram in crystal growth. (CO1, K3)

Or

(b) Describe the gel growth technique and its advantages. (CO1, K4)

12. (a) Differentiate between 1D and 2D nanostructured materials with examples. (CO2, K4)

Or

(b) Explain the basic concept of quantum confinement. (CO2, K3)

13. (a) Discuss the principle of DC magnetron sputtering. (CO3, K3)

Or

(b) Explain the working of spray pyrolysis for thin films. (CO3, K5)

14. (a) Analyze the structural factors responsible for high ionic conductivity. (CO4, K4)

Or

(b) Explain the role of polymer electrolytes in battery. (CO4, K3)

15. (a) Describe the advantages and limitations of liquid penetrant testing. (CO5, K4)

Or

(b) Explain the principle and applications of Acoustic Emission (AE). (CO5, K4)

Part C (5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Describe the Czochralski technique for growing single crystals. (CO1, K4)

Or

(b) Explain the classification of various crystal growth methods. (CO1, K4)

17. (a) Evaluate the sol-gel method for the preparation of nanomaterials. (CO2, K5)

Or

(b) Discuss the excitation confinement in Quantum Dots. (CO2, K5)

18. (a) Compare and contrast PVD and CVD techniques for thin film deposition. (CO3, K4)

Or

(b) Discuss the Ellipsometry method for measuring film thickness. (CO3, K5)

19. (a) Formulate the theories and models of ionic conduction in solids. (CO4, K6)

Or

(b) Analyze mass transport and reactions in lithium ion batteries. (CO4, K6)

20. (a) Explain the construction and working of ultrasonic testing (pulse-echo method). (CO5, K5)

Or

(b) Discuss the principles and types of thermography testing. (CO5, K5)

R4991

Sub. Code
521401

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Fourth Semester

Physics

CONDENSED MATTER PHYSICS – II

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The displacement of the center of the negatively charged electron cloud relative to the positive nucleus is known as (CO1, K1)

   (a) Ionic polarization

   (b) Electronic polarization

   (c) Dipolar polarization

   (d) Orientational polarization

2. The Clausius-Mosotti relation relates the dielectric constant to (CO1, K1)

   (a) Temperature

   (b) Atomic polarizability

   (c) Pressure

   (d) Magnetic field

3. Ferroelectric transition is an example of (CO2, K1)

(a) First order only

(b) Second order only

(c) Order-disorder transition

(d) Magnetic transition

4. Ferrimagnetic materials are characterized by (CO2, K1)

(a) Parallel diploes

(b) Random diploes

(c) Antiparallel dipoles of unequal magnitude

(d) No dipoles

5. Above the curie temperature (Tc) a ferro electric matarial becomes (CO3, K1)

(a) Super conducting (b) Ferro magnetic

(c) Para electric (d) Piezo electric

6. The temperature at which the spontaneous magnetization of a ferro magnetic material vanishes is (CO3, K1)

(a) Neel temperature

(b) Curie temperature

(c) Two critical fields

(d) Zero resistance only

7. Type II super conductors are characterized by (CO4, K2)

(a) No Meissner effect

(b) One critical field

(c) Two critical fields

(d) Zero resistance only

8. In the super conducting state a material exhibits perfect diamagnetism this is known as (CO4, K2)

(a) Peltier effect (b) Meissner effect

(c) Hall effect (d) See beck effect

9. A material with all three dimensions in the nanometer scale is called a (CO5, K1)

(a) Quantum well

(b) Quantum wire

(c) Quantum dot

(d) Thin film

10. Which technique is a "bottom-up" approach for nano material synthesis? (CO5, K2)

(a) Ball milling

(b) Sol-gen method

(c) Lithography

(d) Etching

Part B (5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Calculate the local field (Elocal for a cubic crystal structure and explain the Lorentz field contribution. (CO1, K3)

Or

(b) Explain the phenomenon of Dipole relaxation and its effect on frequency depandence. (CO1, K5)

12. (a) Discuss the classification of Ferro electric crystals with suitable examples. (CO2, K5)

Or

(b) Describe the Piezo electric effect and mention two of its practical applications. (CO2, K3)

13. (a) Differentiate between Ferromagnetism and Anti-ferromagnetism based on susceptibility. (CO3, K4)

Or

(b) Analyze the Langevin's theory of paramagnetism and its limitations. (CO3, K4)

14. (a) Distinguish between Type I and Type II super conductors. (CO4, K4)

Or

(b) Explain the London equations and their significance in super conductivity. (CO4, K3)

15. (a) Classify nanomaterials based on their dimensionality (0D,1D, 2D) with examples. (CO5, K4)

Or

(b) Describe the working principle of Chemical Vapour Deposition (CVD). (CO5, K3)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Derive the Clausius-Mosotti relation and discuss its validity for different dielectrics. (CO1, K4)

Or

(b) Evaluate the theory of electric polarizability and its temperature dependance. (CO1, K5)

17. (a) Formulate the phenomenological theory of the Ferro electric phase transition. (CO2, K6)

Or

(b) Break down the structure of the Ferro electric domain wall and explain why domains form. (CO2, K4)

18. (a) Analyse the Weiss molecular field theory of ferromagnetism and derive the Curie-Weiss Law. (CO3, K4)

Or

(b) Discuss the domain theory of ferromagnetism and the origin of Hysteresis. (CO3, K5)

19. (a) Justify the BCS theory of super conductivity. Explain how electron-phonon interaction leads of cooper pairs. (CO4, K5)

Or

(b) Use the concept of flux quantization to explain the working of a SQUID. (CO4, K4)

20. (a) Design a process flow for the synthesis of nano particles using the Sol-Gel method. (CO5, K6)

Or

(b) Examine the density of states in nano structures and how it changes with dimensionality. (CO5, K4)

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R4992

Sub. Code
521402

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Fourth Semester

Physics

NUCLEAR AND PARTICLE PHYSICS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the questions by choosing the correct option.

1. Nuclear force is _____. (CO1, K1)

   (a) short range

   (b) charge independent

   (d) spin dependent

   (d) all of these

2. The ground state of deuteron is (CO1, K1)

   (a) pure s state

   (b) pure p state

   (c) pure d state

   (d) mixture of s and d state

3. Select the unit of binding energy of nucleus. (CO2, K3)

   (a) eV (b) KeV

   (c) MeV (d) meV

4. Identify the magic numbers from the following : (CO2, K3)

(a) 2, 8, 18, 32, 50, 72, 98

(b) 2, 4, 18, 28, 50, 82, 126

(c) 2, 8, 20, 28, 50, 82, 146

(d) 2, 8, 20, 28, 50, 82, 126

5. Nuclear reaction is said to be endothermic if Q value is (CO3, K2)

(a) equal to zero

(b) greater than zero

(c) less than zero

(d) none of these

6. Heavy water is used in nuclear reactor as a _____. (CO3, K2)

(a) fuel (b) moderator

(c) control rods (d) reactor shield

7. Choose the type of decay in which atomic number increases. (CO4, K2)

(a) β^- (b) β^+

(c) α decay (d) gamma

8. The radiation is used in external beam radiation therapy for cancer treatment is (CO4, K2)

(a) alpha (b) gamma

(c) beta (d) X -ray

9. The strangeness quantum number for nucleons is _____. (CO5, K2)

(a) S = –1 (b) S = 0

(c) S = + 1 (d) S = ∞

10. Leptons are _____. (CO5, K2)

(a) hadrons (b) strange

(c) gluons (d) fermions

Part B (5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Write a short note on noncentral tensor forces. (CO1, K1)

Or

(b) Define the term scattering cross section. Give its significance. (CO1, K1)

12. (a) Define term mass defect, binding energy and binding energy per nucleon. (CO2, K3)

Or

(b) Calculate the ground state angular momentum and parity of $^{17}_{8}\mathrm{O}$. (CO2, K3)

13. (a) Analyse the knock out reaction and stripping reaction. (CO3, K4)

Or

(b) Differentiate thermal neutrons from fast neutrons. (CO3, K4)

14. (a) Discuss the parity violation in beta decay. (CO4, K3)

Or

(b) Give an account Gamow Teller selection rules. (CO4, K2)

15. (a) Describe the quark model of the nucleus. (CO5, K2)

Or

(b) What are called baryons? Give examples. (CO5, K2)

Part C (5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Set up and solve the Schrödinger equation for the ground state of deuteron. (CO1, K1)

Or

(b) Examine the theory of n-p scattering at low energy. (CO 1, K1)

17. (a) Derive the semi empirical mass formula and discuss the mass parabola for odd isobaric nucleus. (CO2, K2)

Or

(b) Elucidate the importance of collective model of the nucleus. (CO2, K4)

18. (a) What are the sources of stellar energy? Give an account on controlled thermo nuclear reactions. (CO3, K2)

Or

(b) State and explain Reciprocity theorem. (CO3, K2)

19. (a) What is called tunnel effect? Give the quantum mechanical theory of alpha decay. (CO4, K3)

Or

(b) What are the difficulties in understanding beta ray spectrum? Outline Fermi's theory of beta decay. (CO4, K2)

20. (a) Describe various types of particle interactions among elementary particles. (CO5, K2)

Or

(b) Explain elementary particle symmetry and arrive at Gellman Okubo mass formula. (CO5, K4)

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R4993

Sub. Code
521403

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Fourth Semester

Physics

THERMODYNAMICS AND STATISTICAL MECHANICS

(CBCS – 2022 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which of the following is intensive variable? (CO1, K1)

   (a) Volume (b) Entropy

   (c) Temperature (d) Internal Energy

2. The area of a cell in phase space for a classical system is (CO1, K1)

   (a) hf (b) h

   (c) zero (d) infinity

3. The condition for the validity of classical statistics is (CO2, K2)

   (a) High density, low temperature

   (b) Low density, high temperature

   (c) Both (a) and (b)

   (d) None

4. In a mechanical ensemble, which parameters remain constant? (CO2, K1)

   (a) E, V, N (b) T, V, N

   (c) M, V, T (d) P, V, T

5. Which statistics is followed by photons? (CO3, K2)
   (a) Maxwell-Boltzmann
   (b) Fermi-Dirac
   (c) Bose-Einstein
   (d) None
6. The fermi energy of a metal depends on (CO3, K2)
   (a) Electron density
   (b) Temperature
   (c) Volume only
   (d) Shape of metal
7. At absolute zero, the probability of finding an electron above the fermi level is (CO4, K1)
   (a) 0 (b) 0.5
   (c) 1 (d) 0.1
8. The mean free path of a gas molecule is inversely proportional to (CO4, K2)
   (a) Temperature (b) Pressure
   (c) Volume (d) Square root of mass
9. The Dulong - petit law fails at (CO5, K2)
   (a) High temperatures
   (b) Low temperatures
   (c) Melting point
   (d) Boiling point
10. The phase transition where latent heat is involved is called (CO5, K1)
   (a) First order (b) Second order
   (c) Lambda transition (d) Zero order

Part B (5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Distinguish between Microstates and macrostates with a suitable example. (CO1, K4)

Or

(b) Derive the Maxwell's thermodynamic relation : $\left(\frac{\partial S}{\partial V}\right)T = \left(\frac{\partial P}{\partial T}\right)V$. (CO1, K4)

12. (a) Explain the Gibbs paradox and how it is resolved using the sackur - Tetrode equation. (CO2, K4)

Or

(b) Compare the basic postulates of Microcanonical and canonical ensembles. (CO2, K5)

13. (a) Derive the Bose-Einstein distribution law for a system of bosons. (CO3, K4)

Or

(b) Calculate the change of states with and without collisions using the Boltzman equation. (CO3, K4)

14. (a) Define Fermi Energy. Calculate the Fermi energy for a 1D electron gas at $T = OK$. (CO4, K3)

Or

(b) Describe the distribution of molecular velocities according to Maxwell. (CO4, K3)

15. (a) Explain the Einstein model of specific heat of solids. (CO5, K4)

Or

(b) Discuss the Clausius - Clapeyron equation for a liquid-vapour phase transition. (CO5, K4)

Part C ($5 \times 8 = 40$)

Answer **all** questions not more than 1000 words each.

16. (a) State the fundamental postulates of statistical Mechanics. Derive the relation between entropy and probability. (CO1, K4)

Or

(b) Derive the Maxwell relation from thermodynamic potentials. (CO1, K5)

17. (a) Using the canonical ensemble, derive tan expression for the partition function of an ideal gas. (CO2, K5)

Or

(b) Breakdown the relation between the ground canonical and canonical partition functions. (CO2, K4)

18. (a) Derive the Fermi-Dirac distribution law. Discuss the behavior of the distribution function at $T = OK$ and $T > OK$. (CO3, K5)

Or

(b) Formulate the Boltzmann Transport Equation and discuss its application to thermal conduction. (CO3, K5)

19. (a) Discus the theory of Black Body Radiation. Derive plans ck's law from Bose - Einstein statistics. (CO4, K5)

Or

(b) What is Bose-Einstein condensation? Explain the conditions under which it occurs. (CO4, K4)

20. (a) Explain the Dbye theory of specific heat of solids and show how it improves upon the Einstein model. (CO5, K5)

Or

(b) Analyze the first order and second order phase transition with examples and phase diagram. (CO5, K5)