Exam Code: 229003 **Paper Code: 3210**
(20)

Programme: Master of Science (Physics)
Semester-III

Course Title: Quantum Mechanics-II

Course Code: MPHL-3391

Time Allowed: 3 Hours **Max Marks: 80**

Note: There are eight questions of equal (16) marks, two in each section. Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section.

SECTION-A

1. Explain the concept of first-order perturbation theory. How does it account for the corrections to the energy levels of a quantum system? (16)
2. (a) Use variation method to evaluate the ground state energy of a particle in the potential defined by

$$V = \begin{cases} \infty \; for \; x < 0 \\ kx \; for \; x > 0 \end{cases}$$

Use $xe^{-\alpha x}$ as the trail wave function.

(8)

(b) Explain how to apply perturbation theory to an oscillator having perturbation proportion to $x^2$and describe the effects of a small perturbation on its energy levels. (8)

SECTION-B

3. Give the theory of Born approximation in scattering calculation and discuss its validity for the scattering by square well potential. (16)
4. (a) Define the optical theorem and explain how it relates the total cross-section to the imaginary part of the forward scattering amplitude. Discuss the physical significance of the optical theorem in scattering experiments. (8)

(b) Discuss the method of partial waves for the study of scattering from a spherically symmetric potential. (8)

SECTION-C

5. Consider a particle described by the Dirac equation in a potential V(r) = -α/r, where on α is a constant. Solve the Dirac equation for this potential and find the energy eigen values and corresponding wave functions. (16)

6. (a) Develop the Klein-Gordon equation for the spin Zero particle. Construct the corresponding continuity equation and discuss its non—relativistic limit. (8)

(b) Demonstrate the Lorentz covariance of Dirac equation and show that Dirac's theory is invariant under vacuum? (8)

SECTION -D

7. Consider a multi-electron atom (e. g., helium or lithium) and describe how the Pauli Exclusion Principle and the concept of exchange degeneracy influence the electron configurations and energy levels of these atoms. (8)

(b) How is the wave function for a system of n-identical particles constructed using Slater determinants? Discuss the necessity of anti-symmetrization for fermions and symmetrization for bosons in the Wave function and the corresponding mathematical expressions. (8)

8. (a) Describe the phenomenon of Bose-Einstein condensation and explain how it arises from the properties of bosons. (8)

(b) Consider an atomic system with three electrons. Calculate the total number of unique quantum states available for the electrons in this system While obeying the Pauli Exclusion Principle. (8)

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Exam Code: 229003 **Paper Code: 3211**
(20)

Programme: Master of Science (Physics)
Semester-III

Course Title: Electrodynamics-II

Course Code: MPHL-3392

Time Allowed: 3 Hours **Max Marks: 80**

Note: Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks. Students can use Non-Scientific calculators or logarithmic tables.

Section A

1. a) Calculate the transverse field components of a rectangular waveguide in TE mode? Derive the expression for cut-off frequency and velocity of the wave? (12)

   b) For hollow cylindrical Waveguide, find the wave number when frequency is less than the cut off frequency? (4)

2. a) Work out energy flow and attenuation factor in a waveguide. Does attenuation depend upon the geometry of the guide? Explain. (12)

b) Define wave impedance and skin depth. (2)

c) Why are rectangular waveguides preferred? (2)

Section B

3. a) A photon of energy $_0$ "bounces" off an electron, initially at rest. Find the energy E of the outgoing photon, as a function of the scattering angle. (12)

b) Consider three inertial frames of reference A, B and C The frame B moves with a velocity C/2 w.r.t A and C moves with a velocity C/10 w.r.t B in the same direction. The velocity of C measured in A will be? (4)

4. a) Derive the Einstein velocity addition rule for x, y and Z axis? (4)

b) Discuss the concept of proper velocity, relativistic energy and momentum. Prove the relativistic energy-momentum relation. (12)

Section — C

5. What is radiation resistance? Calculate the expression for radiation due to a small electric current? Describe why one should not use a small electric current source to radiate electromagnetic energy? (16)
6. Discuss the power for an electric quadrupole and prove that power varies as sixth power of frequency. (16)

Section - D

7. Derive the expression for Larmor's formula for non-relativistic and relativistic cases? (16)
8. Derive the general expression for the angular distribution of power radiated by an accelerated charge? Discuss the case when velocity and acceleration are perpendicular? (16)

Exam Code: 229003 **Paper Code: 3212**
(20)

Programme: Master of Science (Physics)
Semester-III

Course Title: Condensed Matter Physics-II

Course Code: MPHL-3393

Time Allowed: 3 Hours **Max Marks: 80**

Note: Attempt five questions in all by selecting atleast one question from each section. Fifth question may be attempted from any section. Each question carries 16 marks.

Section A

1. (a) Discuss in detail Classification of magnetic materials (8)

   (b) Explain the theory of Langevin Classical theory of Paramagnetism. (8)

2. (a) Write in detail about quenching of orbital angular momentum and cooling by adiabatic demagnetisation (8)

   (b) Explain in detail about paramagnetic susceptibility of conduction electrons (8)

Section B

3. (a) Explain the concept of temperature dependence of spontaneous magnetisation (8)
   (b) Explain the concept of Weiss molecular field and anisotropy energy of ferromagnetic solid (8)
4. Explain each in detail
   (a) Spin Waves (5)
   (b) Bloch wall and its thickness (5)
   (c) Two Sub Lattice Model (6)

Section C

5. (i)Explain in detail
   (a) Critical temperature and critical magnetic field (2)
   (b) Meissner effect (2)
   (c)Type 1 and Type II Superconductors (4)
   (ii) Explain in detail the following
   (a) Flux Quanatisation in a superconducting ring (4)
   (b) a.c and d.c Josephsons effect (4)
6. (i) Explain each in detail
   (a) SQUID (3)
   (b) B.C.S theory of Superconductors (3)
   (c) Thermodynamics of superconducting transition (2)
   (ii) Establish London's equation for superconductors (8)

Section D

7. Explain the following terms
   (a) Absorption process involving impurities
   (b) Photoconductivity
   (c) Reflection and refraction
   (d) Decay Mechanism for luminescence (4x4=16)
8. Explain the following
   (a) luminescence of thalium activated halides
   (b) sulphide phosphors (8,8)

Exam Code: 229003 **Paper Code: 3213**
(20)

Programme: Master of Science (Physics)
Semester-III

Course Title: Nuclear Physics

Course Code: MPHL-3394

Time Allowed: 3 Hours **Max Marks: 80**

Note: Attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 16 marks.

Section-A

1. (a) Show that deuteron is an admixture of S and D state. (8)

   (b) Why deuteron does not have any excited state? (8)

2. (a) Obtain the mathematical expression for cross-section for n-p scattering at low energy? (12)

   (b) What is the significance of the sign of the scattering length? (4)

Section-B

3. (a) Discuss using suitable examples the shell model's rules to predict the spin, parity and magnetic moment of the ground states of different types of nuclei. (10)
   (b) Find the parity, spin and magnetic moment of $_{27}Co^{57}$. (6)

4. What is collective model of nucleus? Discuss the rotational spectra of the nucleus. (16)

Section-C

5. Discuss various selection rules for beta-decay and gamma decay on the basis of parity and angular momentum. (16)

6. Explain the following processes associated with the decay of a nucleus:
   (i) Interval conversion
   (ii) Nuclear isomerism (10+6)

Section-D

7. Discuss in detail the process of nuclear fission. How is it different from nuclear fusion? (16)

8. (a) Using suitable examples, discuss various direct nuclear reactions. (6)
   (b) Discuss Ghoshal's experiment to test the Bohr's hypothesis of decay of compound nucleus. (10)