2M3N24104 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2024

MPH3C09 – Quantum Mechanics – II

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A
(8 Short questions, each answerable within 7.5 minutes)
Answer all questions, each carry weight age 1

1. Define the properties of Dirac matrices.
2. Comment on optical theorem.
3. Memorize the connection formulae is used in WKB method.
4. Outline the variation Principle.
5. What is dipole approximation ?
6. Present Fermi golden rule.
7. Interpret time independent perturbation theory.
8. Find out how the total angular momentum is conserved in Dirac equation.

Total weightage 8x1=8

Section B
(4 Essay questions, each answerable within 30 minutes)
Answer ANY TWO questions, each carry weightage 5)

9. Give the perturbation theory for a degenerate case and discuss weak and strong field Zeeman effect.
10. Using variation method find the ground state energy of Helium.
11. Give the time dependent perturbation theory for the case of a perturbation which is switched on at "$t = 0$" remains constant for the interval" 0 to t" and switched off at time "t".
12. Obtain plane wave solution of Dirac equation.

Total weightage 2x5=10

Section C

(7 Problem questions, each answerable within 15 minutes)
Answer ANY FOUR questions, each carry weightage 3

13. Derive Klein Gordon equation and prove the continuity equation for the same.
14. Explain the negative energy states.
15. Find transition probability in the case of harmonic perturbation.
16. Obtain the energy levels of a linear harmonic oscillator by WKB method.
17. Derive the relationship between scattering amplitude and differential scattering cross section.
18. Why the hydrogen atom in ground state does not show first order stark effect ?
19. Find the 1st and 2nd order correction to the energy of n=1 sate of an oscillator subject to a potential $V(x) = \frac{1}{2} m \omega^2 x^2 + bx$, where " b is independent of x and $bx \ll \frac{1}{2} m \omega^2 x^2$

Total weightage 4x3=12

2M3N24105 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2024

MPH3C10 – Nuclear & Particle Physics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A
(Answer all questions, each carry weightage 1)

1. What is a GM Counter?
2. Explain a multi-channel analyzer.
3. What are mirror nuclei? Give an example.
4. Discuss important properties of deuteron.
5. Explain the principle of operation of a Proportional Counter
6. What are resonance particles ?
7. Write any two characteristics of fission.
8. Explain the conservation of strangeness.

Total weightage 8x1=8

Section B
(Answer ANY TWO questions, each carry weightage 5)

9. Choosing a spin orbit potential for the shell model, analyze the expected energy levels and magnetic moment of nuclei
10. Give an account on the characteristics of nuclear forces.
11. What are the classical experimental tests of Fermi Theory of beta decay ?
12. Explain the Quark model in detail.

Total weightage 2x5=10

Section C
(Answer ANY FOUR questions, each carry weightage 3)

13. Discuss the CNO cycle in fusion reaction.

14. Which of the following reactions are allowed and forbidden under the conservation of strangeness, conservation of Baryon number and conservation of charge ?

    1) $\pi^+ + n \rightarrow K^0 + K^+$

    2) $\pi^- + p \rightarrow \wedge^0 + K^0$

15. For the binomial, Poisson, and Gaussian distributions, derive the expressions for the variance σ^2

16. Find the ground state spins and parities of the following nucleus

    1) $^{33}_{16}S$ 2) $^{17}_{8}O$ 3) $^{17}_{9}F$

17. What are the neo conservation laws in particle physics? Discuss with example.

18. How does the rotational energy level model explain the predicted ratio $E(4^+)/E(2^+)$ is **3.33** for $150 < A < 190$?

19. Evaluate the neutron separation energies of

    (a) ^{7}Li, (b) ^{91}Zr, and (c) ^{236}U

(Total weightage 4x3=12)

2M3N24106 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2024

MPH3C11 – Solid State Physics

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(Answer all questions, each answerable within 7.5 minutes carries weightage 1)

1. Explain the index system for crystal planes.
2. What are the different types of bonding in crystals? Mention their characteristics.
3. Distinguish between type-I and type-II superconductors.
4. What is meant by depolarization field in a dielectric?
5. Explain the term ferromagnetic domain.
6. Write a short note on ferrites.
7. What is Meissner effect? Explain the diamagnetic behaviour of a superconductor.
8. What is Fermi energy of an electron gas?

Total weightage 8x1=8

Section B

(Answer ANY TWO questions, each answerable within 30 minutes carries weightage 5)

9. What are reciprocal lattices? Show the reciprocal lattice to BCC lattice is an FCC lattice and reciprocal lattice FCC lattice is BCC lattice.
10. What is Hall effect? Give an elementary theory on the physical origin of the Hall effect. What are the applications of Hall effect?
11. Explain Debye model of lattice heat capacity and derive an expression for the lattice heat capacity. Discuss the special cases of high and low temperatures.
12. Obtain Curie's law using quantum theory of paramagnetism.

Total weightage 2x5=10

Section C

(Answer ANY FOUR questions, each answerable within 15 minutes and carries weightage 3)

13. Sodium chloride crystallizes in face-centered cubic structure. Taking molecular weight of NaCl as 58.45 and density at room temperature as 2.167 g/cm^3, calculate the lattice parameter, a.
14. Calculate the carrier concentration and conductivity of the intrinsic Ge at T = 300 K. Given that the energy b and gap E_g = 0.68 eV, mobilities of electrons and holes are μ_e= 0.38 m^2/Vs and μ_h= 0.18 m^2/Vs respectively.
15. The critical temperature for mercury with isotopic mass 199.5 is 4.185 K. Calculate the critical temperature when its isotopic mass changes to 203.4. The isotopic effect coefficient for mercury α is 0.5.
16. Find the cut off frequency for a one-dimensional monoatomic lattice. Given that the interatomic spacing is 2.5Å and velocity of sound is 2.5 km/s.
17. A paramagnetic substance has 10^{28} atoms/m^3. The magnetic moment of each is 1.8×10^{-23} Am^2. Calculate the paramagnetic susceptibility at 300 K. What would be the dipole moment of a bar of this material 0.1m long and 1 cm^2 cross section placed in a field of 8×10^4 A/m.
18. Calculate the frequency of the AC current produced when a DC voltage of 5μV is applied across a Josephson junction. What would happen if no voltage is applied across the junction?
19. Derive the Clausius-Mossotti equation which express the relationship between dielectric constant and atomic polarizability.

Total weightage 4x3=12

2M3N24103 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2024

MPH3E05 – Experimental Techniques

(2022 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(8 Short questions, each answerable within 7.5 minutes)

(Answer all questions, each carrying weightage 1)

1. Discuss the function of Gauges in the vacuum systems.
2. Explain the principle of diffusion pump.
3. Explain the phenomena of thermoelectric in thin films.
4. What are thin film interference filters?
5. Explain the Tandem principle used in a van de Graaff accelerator.
6. What are the advantages of a synchrotron over a cyclotron?
7. Explain the method of preparing samples for PIXE measurements.
8. With the help of a diagram explain the instrumentation of the X-ray diffraction technique.

Total weightage 8x1=8

Section B

(4 Essay questions, each answerable within 30 minutes)

Answer ANY TWO questions, each carrying weightage 5)

9. With the help of neat diagrams explain the working principles of
   (a) Turbo molecular pump and (b) Diffusion pump
10. Briefly explain the deposition of thin films using Pulsed Laser Ablation and the advantage of it over other techniques. Use a neat diagram of its instrumentation.
11. Describe the ion implantation technique and ionization process.
12. Draw the experimental set-up for Rutherford Back Scattering experiment and explain the operation. Obtain the expression for the impact parameter.

Total weightage 2x5=10

Section C
(7 Problem questions, each answerable within 15 minutes)
Answer ANY FOUR questions, each carry weightage 3)

13. X-ray diffraction sample in FCC structure is done using X-ray with a wavelength of 0.1514 nm, the peaks obtained at $32^{O}$for first order diffraction calculate the d values and obtain the lattice constant from its (111) reflection.
14. Derive Brags law for X-ray diffraction
15. In a pumping system, a diffusion pump with a pumping speed of 100 Torr liters s^{-1} is backed by a rotary pump. The ultimate pressure achieved in the pumped chamber is 5×10^{-5} Torr. Calculate the pumping speed of the rotary pump.
16. In the vacuum evaporation unit the substrate is kept at a distance of 32cm from the heating boat 8g of a certain material is evaporated completely in the boat. Find the thickness of the film deposited. The thin film is used in an interferometer for thickness measurement. If the wavelength of the light used is 3678 A^{0}, calculate the shift in the fringes, and assume $\mu = 1.5$.
17. In a cyclotron driven at a frequency of 12 MHz, alpha particles are accelerated up to a maximum radius of curvature of 62 cm. The effective voltage applied to the dees is 6 kV. Neglecting the gap between the dees, determine the total acceleration time of the particles and the total distance covered by the particles during the complete cycle of acceleration.
18. In a proton synchrotron, both the frequency of the accelerating electric field and the magnetic field vary with time. Derive a relation between these two quantities, allowing the particles to transverse along a fixed orbit of radius r as they are accelerated.
19. Alpha particles with kinetic energy 3.4 MeV are scattered by the coulomb field of a stationary Pb nucleus (A= 208) .Calculate the differential cross section for the scattering through an angle 60^{0}.

(Total weightage 4x3=12)