2M3N21326 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2021

MPH3C09 – Quantum Mechanics – II

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

(8 Short questions, each answerable within 7.5 minutes)

Answer all questions, each carry weightage 1

1. Distinguish between different types of *Zeeman effect* ?
2. Show that the variational equation is equivalent to time independent Schrodinger equation.
3. State and explain *Fermis Golden rule* for transition to a continuum.
4. What is the criterion for a *Dipole approximation* ?
5. State and explain the optical theorem in scattering theory. Why is the theorem called so.
6. Discuss the *criterion for the validity* of the WKB approximation.
7. What are the limitations of Klein-Gordon equation.
8. Explain the Dirac *Hole theory.*

$(8 \times 1 = 8$ weightage)

Section B

(4 Essay questions, each answerable within 30 minutes)

Answer ANY TWO questions, each carry weightage 5

9. Discuss the theory of WKB approximation. Obtain the connection formula.
10. Using time dependent perturbation theory, derive the transition probability, under harmonic perturbation.
11. Describe Scattering by a central potential using partial wave analysis.
12. Show that Dirac particles possess spin angular momentum and calculate the magnetic dipole moment of Dirac particle.

$(2 \times 5 = 10$ weightage)

Section C

(7 Problem questions, each answerable within 15 minutes)

Answer ANY FOUR questions, each carry weightage 3)

13. Find the first order correction to energy and wavefunction of one dimensional harmonic oscillator ground state, when a perturbing potential e^{-ax} is applied to it.

14. A system in an unperturbed initial state i is suddenly subjected to a constant perturbation $V(r)$ which exists during time $0 \to t$. Find the probability for the transition from initial state i to final state f and show that it varies simple harmonically with angular frequency $E_f - E_i)/2\hbar$ and amplitude $4|V_{fi}|^2/(E_f - E_i)^2$.

15. Use the variational method to estimate the ground state energy of harmonic oscillator. Use the trial wave function as $e^{-\alpha x}$, where α is an adjustable scale parameter.

16. Find the energy levels of a particle in a potential $V(x) = |x|$, using Bohr-Sommerfeld quantisation rule.

17. The differential scattering cross section in a certain case is given by

$$\sigma(\theta) = \alpha + \beta \cos\theta + \gamma \cos^2\theta$$

What is scattering amplitude. Express α, β, γ in terms of phase shifts.

18. Show that the probability associated with a Dirac particle is positive definite.

19. Find the current, charge density and continuity equation associated with Dirac equation.

$(4 \times 3 = 12$ weightage)

2M3N21325 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2021

MPH3E05 – Experimental Techniques

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

SECTION A

(Answer all questions, Each question carries a weight of 1)

1. Give any four applications of accelerators.
2. What are multilayered films? Give their importance.
3. Explain how a typical magnetic valve operated.
4. Give the importance of X-Ray Diffraction technique in crystallography.
5. What is gas ballast in rotary vacuum pump?
6. Why do we need particle accelerators?
7. What is meant by traps in vacuum system?
8. Give the principles of cyclotron.

(8 x1 = 8 Weightage)

SECTION B

(Answer any two questions, Each question carries a weight of 5)

9. Explain the principles of RBS technique. Giving a neat diagram describe the experimental setup for elemental analysis using this technique. What are the applications of this method?
10. With the help of a neat diagram explain the instrumentation of X-Ray diffraction technique and how does XRD determine crystal structure?
11. Discuss the principle of Glow Discharge technique and factors influencing the deposition rate. Give a diagram of experimental setup used and explain the details and working.
12. Draw a neat diagram of oil sealed rotary vacuum pump. Explain the principle, and working also explain the two stage vacuum pump.

(2 x 5 = 10 Weightage)

SECTION C

(Answer any four questions; each question carries a weight of 3)

13. Alpha particle with KE 1.7Mev are scattered by Coloumb field of stationary Pb nucleons (A=206). Calculate the differential cross-section for the scattering through an angle 60°.
14. In a cyclic proton synchrotron, protons are accelerated from 0.5MeV to 1000 MeV. The orbital radius is 4.5m. Let the magnetic field grows at a constant rate of 15kG/s. Determine the limits with in which the frequency of the accelerating field varies and total acceleration time. Also calculate the energy acquired by the protons in one revolution and the distance covered and the number of revolution made during the acceleration cycle.
15. For an electron and proton moving along circle in uniform magnetic field B=10 kG. Determine the orbital periods and radii if the kinetic energy of the particle is 10MeV. Also find the kinetic energies if the orbital radius is 10 cm.
16. With the help of a diagram, describe the principle and working of a Cascade accelerator
17. A vacuum pump with speed of 1000 liter/sec is connected to a chamber with an out gassing rate of 10^{-4} torr liter/sec. what is the expected ultimate pressure?
18. Explain the principles of quartz crystal method for determining the thickness of thin films.
19. From the given table; data obtained from a XRD pattern, calculate the grain sizes of materials (Wavelength of X-ray used was 1.5406 Å)

Peak position 2θ (°)	FWHM (°)
38	1.21
35.16	0.469
37.8	0.463
43.4	0.502

(4 x 3 = 12 Weightage)

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Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2021

MPH3C10 – Nuclear and Particle Physics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

SECTION A

Answer *ALL* questions. Each carries *ONE* weightage

1. What is meant by binding energy of a nucleus? Give the expression.
2. What is scattering amplitude? How is it related to the scattering cross-section?
3. What are allowed and forbidden beta decays? Give examples.
4. Explain internal conversion process.
5. What are the important features of the collective model of the nucleus?
6. Which are the important reactions responsible for energy production in solar fusion?
7. Mention the properties of an ideal scintillator.
8. What are coloured quarks and gluons?

(8 × 1 = 8 weightage)

SECTION B

Answer any *TWO* questions. Each carries *FIVE* weightage.

9. Give the theory of partial wave analysis of neutron-proton scattering and obtain the expression for total cross section at low incident energies.
10. Discuss the Fermi's theory of beta decay and explain Fermi-Kurie plot.
11. Describe the essential features of the shell model. Explain how the model is able to predict the ground state spins and parities of nuclei.
12. Explain the working of a Geiger Muller counter with the help of a neat diagram.

(2 × 5 = 10 weightage)

SECTION C

Answer any *FOUR* questions. Each carries *THREE* weightage

13. The difference in Coulomb energy of the mirror nuclei $_{24}Cr^{49}$ and $_{25}Mn^{49}$ is 6.0 MeV. Assuming a spherical charge distribution in nuclei, calculate the radius of $_{25}Mn^{49}$ nucleus in fermi. Take $\frac{e^2}{4\pi\varepsilon_0} = 1.0$ MeV-fm.

14. Predict the multipole moments of the radiations emitted during the following gamma transitions:

(a) $1^+ \rightarrow 0^+$ (b) $2^+ \rightarrow 0^+$ (c) $3^- \rightarrow 0^+$ (d) $4^+ \rightarrow 1^-$

15. Using the semi empirical mass formula, find the atomic number of the most stable nucleus corresponding to mass number A = 216. Given the coulomb energy coefficient $a_c = 0.7$ MeV and the asymmetry energy coefficient $a_{asy} = 22.5$ MeV.

16. The rotational band spectrum of the nucleus $_{92}U^{238}$ is based on 0^+ ground state. If the energy of the 2^+ state is 44.7 keV, calculate spin and parity of the state having energy 525 keV.

17. Calculate the pulse height obtained from a proportional counter when a 14 keV electron gives up all its energy to the gas. The gas multiplication factor of the counter is 600, capacitance of the circuit is 1.0 pF and energy required to produce an ion pair is 35 eV.

18. Determine whether the following reactions are allowed or forbidden:

(a) $n \rightarrow p + e^- + \bar{\nu}_e$ (b) $p + p \rightarrow K^+ + \Sigma^+$

(c) $p + \pi^- \rightarrow \Sigma^0 + \eta^0$

19. Give the quark structure and spins of the following particles using the quark model

p, n, Δ^+, π^-, Σ^0, and Ξ^- .

(4 × 3 = 12 weightage)

2M3N21328 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Degree Examination, November 2021

MPH3C11 – Solid State Physics

(2019 Admission onwards)

Time: 3 hours Max. Weightage : 30

Section A

Answer all questions, each carry weightage 1

1. What is Madelung interaction?
2. Briefly explain hydrogen bond
3. Plot the first and second Brillouin zones in a two dimensional k-space
4. Distinguish between direct band gap and indirect band gap semiconductors.
5. State Hund's rules to represent ground state of an atom in terms of angular momenta.
6. Explain Hall Effect
7. What is flux quantization of a super conducting ring?
8. What are Cooper pairs and explain how they are formed?

(8x1=8 weightage)

Section B

Answer ANY TWO questions, each carry weightage 5

9. Discuss the theory of Kronig – Penny model and show how energy bands are formed
10. Discuss the Debye model of lattice heat capacity and derive an expression for heat capacity. How does the result agree with experimental data?
11. Discuss the Landau theory of displacive ferroelectric phase transition
12. Distinguish between DC and AC Josephson effect. Find the current in AC Josephson junction

(2x5=10 weightage)

Section C

Answer ANY FOUR questions, each carry weightage 3

13. Show that the reciprocal lattice of a simple cubic (SC) and body centered cubic (BCC) are SC and FCC (face centered) respectively.
14. The potential energy of a diatomic molecule in terms of inter atomic separation 'r' is given by $U(r) = -A/r^2 + B/r^{10}$, where $A = 1.44 \times 10^{-39}$ Jm^2 and $B = 2.19 \times 10^{-115}$ Jm^{10}. Calculate the equilibrium spacing R_e and dissociation energy
15. Debye temperature for diamond is 2000K. Calculate the mean velocity of sound in diamond (Z = 12u, and density is 3.5×10^3 Kg/m^3). Also find the frequency of dominant mode of lattice vibrations of inter atomic spacing is 1.54 Å.
16. Obtain an expression for electron concentration in conduction band of intrinsic semiconductor
17. Calculate the Hall coefficient of Na based on free electron model. (Na – BCC structure with lattice parameter a = 4.28 Å)
18. Obtain the condition for polarization catastrophe for a polarizable cubic ionic crystal.
19. Write a short note on spin waves and magnon in ferromagnets.

(4x3=12 weightage)