1M3N23104

(Pages : 2)

Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2023

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 weightage 1

1. Show the reason behind Dirac matrices being 4 x4 matrices.
2. Comment on the relationship between scattering amplitude and differential scattering cross section.
3. Memorize hole theory.
4. Outline the variation principle.
5. Explain stimulated and spontaneous emission on the basis of time dependent perturbation theory.
6. Present Fermi golden rule.
7. What are the difficulties with Klein Gordon equation?
8. Interpret time dependent perturbation theory.

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 theory of first order Stark effect on the basis of perturbation theory and discuss the splitting of spectral lines.
10. Outline WKB method for one dimensional case and derive the connection formulae.
11. What is meant by scattering cross section ? Derive the scattering amplitude by the method of partial wave analysis.
12. Show that Dirac wave equation endows the electron a magnetic moment. How it is interpreted Physically ?

Total weightage 2x5=10

Section C

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

13. Show that the total angular momentum is conserved in Dirac equation.
14. Derive the relationship $\sigma.A\ \sigma.B = i\sigma.\ A \times B$
15. Find transition probability in the case of constant perturbation.
16. Find the ground state energy of Helium using variation method.
17. Derive the Optical theorem.
18. Discuss the effect of a weak magnetic field on the energy state of an atom using perturbation theory.
19. Calculate the 1st order correction to the ground state of an anharmonic oscillator of mass m and angular frequency ω subject to a potential $V(x) = \frac{1}{2}\ m\ \omega^2 x^2 + bx^4$

Total weightage 4x3=12

1M3N23105

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Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2023

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 Proportional Counter?
2. Define internal conversion coefficient?
3. The beta ray spectrum is continuous. Why?
4. Write a short note on extreme independent particle model.
5. Discuss the Yukawa's theory of nuclear forces.
6. What are basic fusion processes ?
7. What is a photo multiplier tube?
8. Define isospin of nucleus.

Total weightage 8x1=8

Section B

(Answer ANY TWO questions, each carry weightage 5)

9. Discuss the nucleon-nucleon scattering using partial wave analysis.
10. What are the evidences of Shell model and how it explains the properties of nuclei.
11. Explain Fermi Theory of beta decay.
12. Discuss the Eight fold way and illustrate it in the case of Baryon and Meson octets .

Total weightage 2x5=10

Section C

(Answer ANY FOUR questions, each carry weightage 3)

13. Briefly discuss about the single channel analyzers and multi-channel analyzers
14. How do you explain "the nucleon-nucleon interaction is strongly spin dependent"?
15. Discuss the conservation laws for the following reactions,

1) $\wedge^0 \rightarrow p + \pi^-$

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

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

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

    1) $^{13}_{7}N$ 2) $^{17}_{8}F$ 3) $^{41}_{20}Ca$

17. Discuss the proton-proton cycle in fusion reaction.

18. Discuss the mass parabola for A=125 and 128. What is the relevance of mass parabola?

19. Evaluate the proton separation energies of

    (a) ^{7}Ne, (b) ^{55}Mn, and (c) ^{197}Au

(Total weightage 4x3=12)

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Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2023

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. What are Brillouin zones? Construct the first Brillouin zone for a two-dimensional square lattice.
2. What are Miller Indices? Draw the planes for Indices (100), (110) and (111)
3. What are the basic assumptions of Debye model of heat capacity of solids?
4. How do the electronic and lattice heat capacity contributions of metals vary with temperature at low temperature?
5. Distinguish between direct and indirect bandgap semiconductors.
6. Briefly explain the concept of magnons in ferromagnets.
7. Distinguish between type-I and type-II superconductors.
8. What is meant by isotopic effect in superconductivity?

Total weightage 8x1=8

Section B

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

9. Derive the dispersion relationship for a one-dimensional atomic crystal and discuss the nature of acoustic and optical modes?
10. Explain the energy gap in semiconductors. Obtain the relation for intrinsic carrier concentration of a semiconductor at thermal equilibrium.
11. Explain DC and AC Josephson's effects and explain their importance.
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. Calculate the glancing angle on the plane (110) in a cubic crystal of a rock salt with lattice parameter a=2.814 Å corresponding to second order diffraction maximum for X-rays of wavelength 0.710 Å.
14. Sodium has an electron density of $2.65 \times 10^{28}/m^3$. If it has a room temperature conductivity of $2.04 \times 10^7 \Omega^{-1} m^{-1}$, calculate electron mean free path in this metal.
15. If the electron concentration in a superconducting material at absolute zero temperature is $10^{29}/m^3$, calculate London penetration depth assuming all electrons in the sample are superconducting electrons at 0 K.
16. Calculate the magnetic susceptibility for a paramagnetic material with number density $9 \times 10^{28}/m^3$ at 500 K. Also find Curie constant of the material. ($\mu_B = 9.27 \times 10^{-24} Am^{-2}$)
17. Copper has a free electron density of $8.5 \times 10^{28}\ m^{-3}$. If the current density of a wire of copper is $10^7\ Am^{-2}$, find the drift velocity of electrons in it. Compare it with Fermi velocity for electrons in copper.
18. An elemental dielectric has $\varepsilon_r = 12$ and it contains 5×10^{28} atoms/m^3. Calculate its electronic polarizability assuming Lorentz field.
19. Estimate the Debye temperature of gold. Its atomic weight is 197, the density is 1.9×10^4 kg/m^3 and the velocity of sound in it is 2100 m/s.

Total weightage 4x3=12

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Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Physics Degree Examination, November 2023

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. Explain the quantity 'the throughput' of a system.
2. Draw the internal structure of a rotary pump in its various stages of operations.
3. Discuss any two vacuum valves.
4. How the thickness of a thin film can be measured by using electrical conductivity measurement? Site a technique as an example.
5. What are drift tubes and explain the role of length in drift tubes?
6. Which experimental technique is known as the depth profile analysis technique and why?
7. What is glow discharge sputtering and discuss different types of glows?
8. Distinguish between Single crystal XRD and Powder XRD.

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) Bourdon Gauge (b) Pirani Guage (c) Thermocouple Guage
10. Discuss the electron beam physical vapor deposition techniques, and explain the advantages and disadvantages of it.
11. Discuss ion beam sputtering, its principle, and applications.
12. Draw the experimental set-up Proton induced X-ray Emission-principle and the role of various sample analysis.

Total weightage 2x5=10

Section C

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

13. A sample in FCC structure is irradiated with a beam of X-rays of wavelength 1.514 A^0 and diffraction is obtained from the (110) plane of it and the lattice constant of it is 12nm and hence finds the angle for the second-order diffraction.
14. (a) Determine the mean free paths of a gas at the pressure of 10^{-3} Torr, 10^{-5} Torr, and 10^{-7} Torr for a pump of 10^{-8}cm diameter.

    (b) What should be the speed of a rotary pump to be used to achieve a pressure of 5m bar in a chamber of volume 100 litters in 20 minutes?
15. A quartz crystal monitor indicates a change in frequency of 1700 Hz when an aluminum film of density 4.2 gm/cm^3 is deposited on its face. Determine the film thickness. If the quartz crystal is 0.2 mm and the density of the quarts is 2.3gm/cm^3. Estimate the starting frequency of the crystal.
16. Calculate the interplanar spacing and FWHM for grains of sizes 42nm, 34nm, and 18nm of a polycrystalline sample for when first-order x-rays reflected at angles $2\theta = 24^0, 36^0, 44^0$using x-rays of wavelengths1.514 A^0.
17. Protons are accelerated in a synchrotron in a stable orbit of 11 m radius, the protons complete one revolution per microsecond, calculate the kinetic energy of the protons.
18. An alpha particle with a momentum 54 Mev/C is scattered at an angle of 80^0 by the coulomb field of stationary Pb molecule (Z=82, A=208). Find the impact parameter.
19. The calibration constant K for a particular trace element using the PIXE setup was 3200 counts/ µgm/µC . For the internal standard elements used with a concentration of 90 ppm, the corresponding value is 475, Evaluate the concentration of the trace elements considered.

(Total weightage 4x3=12)