1M3N19212 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc. Physics Degree Examination, November 2019

MPHY3E07 – Experimental Techniques

(2018 Admission onwards)

Time: 3 hours Max. Weightage : 36

Section-A

Answer all Twelve Questions

Each question carries a weightage of 1

1. Discuss Vacuum gauges.
2. Describe Baffle and isolation valves.
3. Discuss the variation of pumping speed with pressure for a rotary pump.
4. What is meant by liquid nitrogen traps in vacuum system?
5. Outline the advantages of Neutron activation analysis.
6. Give the basic steps to deposit a thin films by physical evaporation technique with the help of a schematic diagram?
7. Explain internal structure and morphology in thin films
8. How does a synchrotron overcome the difficulties experienced by a cyclotron?
9. Explain the principles of phase stability in a synchro cyclotron.
10. What are the various factors to be considered in choosing a particular nuclear technique for the elemental analysis?
11. What is meant by energy straggling. How does it affect the spectrum of ion scattered from a target.
12. Explain the term kinematical factor and give its importance.

(12 x 1 = 12 weightage)

Section-B
Answer any Two Questions
Each question carries a weightage of 6

13. With the help of a diagram explain the various parts and working of an Pirani gauge, and penning guage
14. Discuss with the schematic diagram the working of sputtering technique for thin film deposition: Explain sputtering yield.
15. Discuss the basic requirement for an elemental analysis, describe the experimental requirement for it and the mathematical basis of the quantitative estimate.
16. Explain the principle of PIXE technique with a neat diagram. Describe the experimental arrangement for PIXE also give the application.

(2 x 6 = 12 weightage)

Section-C
Answer any Four Questions
Each question carries a weightage of 3

17. Derive Rutherford's scattering cross section formula
18. Derive Brags law, Explain how XRD pattern can be used to determine the crystal structure of an material and discuss grain size calculation using XRD
19. A vacuum pump with speed of 1000 liters per sec is connected a chamber with an out gassing rate of 10^{-4} Torr liters s^{-1}. What is the expected ultimate pressure?
20. Describe the thickness measurements in thin films using any two methods
21. A quartz crystal monitor indicates a change in frequency of 1600Hz when an aluminium film of density 2.7gm/cm^3 is deposited on its face. Determine the film thickness if the quartz crystal is 0.2mm is thick and the density of quartz is 2.3gm/cm^3. Estimate the starting frequency of the crystal
22. Proton of energy 0.5MeV is injected in to a 50 MeV linear accelerator powered by a 200 MHz RF supply. Find the approximate length of the first and last drift tubes

(4 x 3 = 12 weightage)

1M3N19213 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc. Physics Degree Examination, November 2019

MPHY3B09 – Quantum Mechanics – II

(2018 Admission onwards)

Time: 3 hours Max. Weightage: 36

Section A

Answer all questions

Each question has weightage of 1.

1. WKB method is called a semi-classical method.Why ?
2. Explain quantum mechanical *tunneling* with examples.
3. Give any two problems that can be treated with perturbation theory. Also write the perturbed Hamiltonian.
4. What is *Zeeman effect* ? How can we study it using perturbation theory ?
5. Show that the variational equation is equivalent to time independent Schroedinger equation.
6. State and explain *Fermis Golden rule* for transition to a continuum.
7. What is the criterion for a *dipole approximation* ?
8. What are the limitations of Klein-Gordon equation.
9. Express Dirac equation in *covariant* form.
10. Give any 4 properties of Dirac matrices.
11. Compare the classical field equation in terms of *Lagrangian density* with Euler-Lagrange equation in Classical Mechanics.
12. Explain the *occupation-number representation.*

$(12 \times 1 = 12$ weightage)

Section B

Answer any two questions
Each question has weightage of 6.

13. Discuss the theory of WKB approximation. Obtain the connection formula. Use it study the problem of barrier tunneling

14. Using time dependent perturbation theory, derive the transition probability, under harmonic perturbation.

15. Show that Dirac particles possess spin angular momentum and calculate the magnetic dipole moment of Dirac particle.

16. Derive the Klein-Gordon relativistic wave equation of a free particle. Determine the current density and probability density.

$(2 \times 6 = 12$ weightage$)$

Section C

Answer any four questions
Each question has weightage of 3.

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

18. 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.

19. 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.

20. A simple harmonic oscillator of mass m_0 and angular frequency ω is perturbed by an additional potential bx^3. Evaluate the second order correction to the ground state energy of the oscillator. Given that $\hat{x} = \sqrt{\frac{\hbar}{2m_0\omega}}\left(\hat{a} + \hat{a}^\dagger\right)$.

21. 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 f and show that it varies simple harmonically with angular frequency $(E_f - E_i)/2\hbar$ and amplitude $4|V_{fi}|^2/(E_f - E_i)^2$.

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

$(4 \times 3 = 12$ weightage$)$

18

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Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc. Physics Degree Examination, November 2019

MPHY3B10 – Nuclear and Particle Physics

(2018 Admission onwards)

Time: 3 hours Max. Weightage: 36

Section A

Answer ALL questions. Each question carries 1 weightage.

1. Give the relationship between the radius of a nucleus and its mass number. How the matter density in a nucleus varies with its mass number?
2. Draw the binding energy curve. What is its importance?
3. Write down the semi-empirical mass formula and explain the origin of asymmetry energy
4. Describe the spin dependence of nuclear forces, giving an example.
5. Define scattering cross section. Explain its significance.
6. Why there are no magic numbers that are odd?
7. Write a note on collective model of nucleus.
8. Distinguish between allowed and forbidden decays?
9. Explain the multipole moments associated with radiations emitted during gamma decays.
10. What are compound nucleus reactions?
11. What are D-D and D-T reactions? How much energy is released in these reactions?
12. State end explain the TCP theorem.

(12x1=12 Weightage)

Section B

Answer any TWO questions. Each question carries 6 Weightage.

13. Give evidences for the existence of shell structure in a nucleus. Describe with theory how nuclear shell model accounts for magic numbers.
14. Give a detailed account of the Fermi's theory of beta decay.
15. Explain the important features nuclear fission process. Describe the working of a nuclear fission reactor that operates with natural uranium fuel.
16. (a) Describe the fundamental forces in nature. Explain the characteristic features of each force.

    (b) Describe the classification of elementary particles.

(2x6=12 Weightage)

Section C

Answer any FOUR questions. Each question carries 3 Weightage.

17. Calculate the distance of closest approach of a 4 MeV proton to a ^{79}Au nucleus.
18. Obtain a relationship between the depth and width of the well and binding energy in the square well model of deuteron.
19. Using shell model, predict the spin and parity of the nuclei ^{17}O (Z = 8) and ^{14}N (Z = 7
20. $_6C^{11}$ decays to $_5B^{11}$ by β^+ emission. Calculate the maximum and minimum energies of t neutrino emitted. Given atomic masses of $_6C^{11}$ = 11.011433 u, $_5B^{11}$ = 11.00935 u and mass of electron = 0.0005 u.
21. Calculate the energy liberated when a helium nucleus is formed by the fusion of two deuterons. Given the mass of $_1H^2$ = 2.01478 u and mass of $_2He^4$ = 4.00388 u.
22. Analyse the following decays or reactions for possible violations of the basic conservati laws :
    (a) $\pi^+ + n \rightarrow \Lambda^0 + K^+$
    (b) $\pi^+ + n \rightarrow K^0 + K^+$
    (c) $\pi^- + p \rightarrow \Lambda^0 + K^0$
    (d) $K^- + p \rightarrow \Sigma^- + \pi^+$

(4x3=12 Weightage

1M3N19215 (Pages : 2) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc. Physics Degree Examination, November 2019

MPHY3B11 – Solid State Physics

(2018 Admission onwards)

Time: 3 hours Max. Weightage: 36

PART A

Answer *all* questions.
Each question carries 1 weightage

1. What are Miller Indices? How are they determined?
2. What do you mean by Brillouin zones?
3. Differentiate between direct band gap and indirect band gap semiconductors.
4. State and explain Weidmann and Franz law.
5. Define relaxation time and collision time of free electrons in metals.
6. What are ferrites?
7. What do you mean by polarization catastrophe?
8. Write a note on ferroelectric domain.
9. Explain NeeI's theory of antiferromagnetism.
10. How does the specific heat capacity in a superconductor vary of with temperature?
11. Write a short note on high temperature superconductivity.
12. What is the origin of energy gap in super conductors?

(12x1=12 weightage)

PART B

Answer any 2 questions.
Each question carries 6 weightage

13. Discuss the Debey model for specific heat capacity and derive an expression for the lattice heat capacity. How it agrees with experimental results at high and low temperature?
14. Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. What is meant by density of energy states?
15. Discuss the Landau theory of ferroelectric phase transition.
16. Discuss ac Josephson effect. Derive an expression for the frequency of current oscillation.

(2x6=12 weightage)

PART C

Answer any 4 questions.
Each question carries 3 weightage

17 The Bragg angle for reflection from (111) planes in Al is 19.2^0 for an x-ray beam of wavelength 1.54 A^0. Calculate (a) the lattice constant of Al and (b) the interplanar spacing for these planes.

18 The thermal conductivity maximum of a synthetic sapphire sample of 3 mm diameter is observed at 30K. The measured maximum value is $2.7X10^4$ $Wm^{-1}K^{-1}$. If the speed of sound in sapphire is 10^4 ms^{-1}, calculate the heat capacity of the sapphire at 30K.

19 Prove that the reciprocal lattice for a bcc lattice is a fcc structure.

20 The intrinsic resistivity of Ge at 300 K is 47 Ω cm. What is the intrinsic carrier concentration, when electron and hole mobilities in Ge at 300 K are 3900 cm^2/Vs and 1900 cm^2/Vs respectively?

21 A magnetic material has a magnetization of 3200 A/m and flux density of 0.0045 Wb/m^2. Determine the magnetic field and relative permeability of the material.

22 Calculate the critical current for a wire of lead having a diameter of 1 mm at 4.2 K. The critical temperature for lead is 7.18 K and $H_c(0)= 6.5X10^4$ A/m

(4x3=12 weightage)