

[4]

6. a) Set up the Schrodinger equation for a 1-D linear harmonic Oscillator. Obtain expression for eigen functions and energy eigen value. 6

OR

- b) Solve the Schrodinger's equation for a particle moving in a 1-D box having perfectly rigid and elastic walls.

7. a) Describe the principle, experimental arrangement and results of Stern-Gerlach experiment. 6

OR

- b) Describe normal Zeeman effect.

L-381-1200

V-UG-Phy(CC)-XI

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

Part-I

1. Answer the following :

1 × 8

- a) The expression $|\Psi|^2$ represents ____.
- b) Define norm of a wave function.
- c) What is an operator ? Give example.
- d) The value of $[L_x, x]$ is ____.
- e) What is the zero point energy of a harmonic oscillator ?
- f) Define stationary state.
- g) The value of One Bohr magneton is ____.
- h) What is Zeeman effect ?

Part-II

2. Answer any *eight* of the following :

1½ × 8

- a) State super position principle.
- b) Explain probability current density.

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[Turn Over

[2]

- c) Find $[x, P_x]$
- d) What is energy eigen spectrum ?
- e) Write two applications of tunneling effect.
- f) Explain potential barrier.
- g) Show that Hermitian operators have real eigen value.
- h) What is Stark effect ?
- i) Explain Larmor's theorem ?
- j) What is Bohr magneton ?

Part-III

3. Answer any *eight* of the following : 2 × 8
- a) Write the physical conditions for a wave function to be acceptable and normalizable.
 - b) Find the normalisation constant of the wave function $\psi(x) = Ae^{\frac{-\alpha^2 x^2}{2}} e^{ikx}$.
 - c) Write down the characteristics of a free particle.
 - d) Show that the momentum operator is Hermitian.
 - e) Evaluate $[x, H]$, if $H = \frac{p^2}{2m} + \frac{1}{2} \omega^2 x^2$.
 - f) Calculate the ground state energy for a particle of mass 10g moving in a box of length 10cm.

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- g) Define reflectivity and transmittivity.
- h) Explain Paschen-Back effect.
- i) Define gyromagnetic ratio. Write its formula.
- j) Calculate the precessional frequency of an electron orbiting in a magnetic field 5T. Give $m_e = 9.1 \times 10^{-31} \text{kg}$

Part-IV

4. a) Derive expression for time dependent Schrodinger's equation in 1-D in a potential field. Write down the interpretation of a wave function. 6
- OR
- b) What is wave packet ? Describe Gaussian wave packet and find its width.
5. a) State and prove Ehrenfest's 1st theorem ? 6
- OR
- b) For any two operators \hat{P} and \hat{Q} which commute with their commutator $[\hat{P}, \hat{Q}]$, show that $[\hat{P}^n, \hat{Q}] = n\hat{Q}^{n-1}[\hat{P}, \hat{Q}]$

L-381

[Turn Over

[4]

5. a) Describe X-ray diffraction. State and derive Bragg's law of crystal diffraction. 6

OR

b) Define Miller index. Write down the procedure for finding Miller indices. Derive expression for inter planar spacing using Miller indices.

6. a) Derive expression for Clausius-Mosotti equation. 6

OR

b) Derive expression for Einstein's A, B coefficients.

7. a) Derive 1st and 2nd London's equations. 6

OR

b) Describe Kronig-Penny model for an electron in 1-D periodic potential.

L-419-1200

V-UG-Phy-(CC)-XII

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

Part-I

1. Answer the following : 1 × 8

a) Define unit cell.

b) The number of Bravais Lattice in 3D is ____.

c) State Curie law.

d) The quantum of lattice energy is called ____.

e) Define dielectric. Give example.

f) Define polarisation vector, Write its unit.

g) What is the charge on a p-type semiconductor ?

h) Define super conductivity.

Part-II

2. Answer any *eight* of the following : 1½ × 8

a) Define miller indices.

b) Distinguish between crystalline and amorphous solids.

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[Turn Over

[2]

- c) Write the basic difference between Einstein and Debye theory.
- d) Calculate the magnetic dipole moment of a bar magnet 10cm long and pole strength 10 N/T .
- e) What is ionic polarization ?
- f) What is population inversion ?
- g) Write two applications of Ruby LASER.
- h) What is a hole ? What is hole current in a semi conductor ?
- i) Plot a graph between kinetic energy and wave vector \hat{k} of the free electron.
- j) Define atomic structure factor.

Part-III

3. Answer the *eight* of the following : 2×8
- a) Write down four properties of reciprocal lattice.
 - b) Write difference between crystal and lattice.
 - c) Find Miller indices of a set of parallel planes having intercepts in the ratio $2a : 3a$ on X and Y axis and are parallel to Z- axis.

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- d) Draw $B \sim H$ curve and discuss briefly.
- e) Calculate the group velocity of two sinusoidal waves
 $y_1 = 0.05 \cos (15t - 8x)$ and
 $y_2 = 0.07 \cos (10t - 4x)$
when superimposed each other in S.I. unit.
- f) Show that the polarisation of a dielectric is numerically equal to the surface charged density.
- g) Derive relation between \vec{D} , \vec{E} and \vec{P} .
- h) Write various types of polarisation.
- i) Explain isotope effect.
- j) Define penetration depth. Write its expression.

Part-IV

4. a) Describe Debyi's theory of specific heat of solid.
- OR
- b) Describe Largevin theory of paramagnetism.

6

Part-IV

4. a) Derive Lagrange's equation from D'Alembert's principle. 7

OR

- b) What is a compound pendulum ? Derive Lagrange's equation for compound pendulum. Find its time period.

5. a) Derive Lagrange's equation from Hamilton's principle. 7

OR

- b) Discuss equivalent 1-D problem and the classification of orbits from it.

6. a) Derive Lorentz transformation equation. 7

OR

- b) Derive mass energy relation and find a relation between total energy, rest energy and momentum.

7. a) Discuss space like and time like intervals. 7

OR

- b) Describe relativistic Doppler's effect from four vectors perspective and hence discuss the case of Longitudinal Doppler's effect.

L-457-1200



2021

Full Marks - 80

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer all questions

Part-I

1. 1. Answer the following by fill in the blanks or one word answer : 1×12
- a) Lagrangian of a system is the ___ between K.E. and P.E.
- b) Write expression for generalised displacement.
- c) Selection of generalised co-ordinates is a unique method. (State true or false)
- d) Define Hamiltonian function.
- e) Lagrange's differential equation of motion are ___ order differential equation.
- f) For hyperbolic orbit, value of energy is ___.
- g) What is the mass of a photon ?
- h) State 1st postulate of special theory of relativity.
- i) Write expression for position four vector.
- j) Write expression for mass energy relation.

L-457

[Turn Over

[2]

- k) For an N-particle system with k-constraints the number of degree of freedom is ____.
- l) A four vector has ____ space like and ____ time like component.

Part-II

2. Answer any *eight* of the following : 2×8
- a) What are generalised co-ordinates.
 - b) Describe an Atwood's machine with figure.
 - c) What are cyclic co-ordinates ?
 - d) State principle of virtual work.
 - e) Describe Brachistochrone.
 - f) Calculate the speed of a clock which may appear to lose 5 minutes in each hour.
 - g) Define inertial frame of reference with example.
 - h) Calculate the energy of electron at rest in MeV. if mass of electron is 9.11×10^{-31} kg.
 - i) Discuss longitudinal Doppler effect when $\theta = 0^\circ$.
 - j) Write expression for momentum four vector.

[3]

Part-III

3. Answer any *eight* of the following : 3×8
- a) Write down the characteristics of virtual displacement.
 - b) Using D'Alembert's principle, find the equation of motion of a simple pendulum.
 - c) Find expression for Lagrangian of a 1-D harmonic Oscillator.
 - d) State Hamilton's principle.
 - e) Find the Hamiltonian of a system of the Lagrangian of the system is $L = ax^2 + by^2$.
 - f) Set up the Lagrangian of a particle of mass m, constrained to move on the plane curve $xy = C$ ($C > 0$) under gravity.
 - g) Find the kinetic energy of an electron that moves with a velocity 2×10^8 m/s, if the rest mass energy of electron is 0.512 MeV.
 - h) Prove that the 4-D volume element $dx dy dz dt$ is invariant under Lorentz transformation.
 - i) Discuss transverse Doppler's effect.
 - j) Explain Light like intervals.

L-457

[Turn Over

b) Discuss β -decay process and the energy released during this process.

5. a) What is semiempirical mass formula ? Explain the importance of various terms. 7

OR

b) What is shell model ? Write down the assumptions and the success of shell model.

6. a) Describe the construction and working theory of GM. counter. 7

OR

b) Describe the construction, working and theory of linear accelerator.

7. a) Name four fundamental interactions and briefly discuss about them. 7

OR

b) Write short notes on the following :

- i) Quarks
- ii) Gluons.

L-494-1200



The figures in the right-hand margin indicate marks
Answer *all* questions

2021

Full Marks - 80

Time - 3 hours

Part-I

1. Answer the following by fill in the blanks or one to two words answer : 1 × 12

- a) The expression for binding energy, $E = \underline{\hspace{2cm}}$.
- b) Name the radioactive ray which is not deflected by electric and magnetic field.
- c) The shell model fails to explain $\underline{\hspace{2cm}}$ values.
- d) Write expression for maximum value of pulse height.
- e) In liquid drop model, nuclear forces are analogous to $\underline{\hspace{2cm}}$ of liquid.
- f) The asymmetry energy arises due to $\underline{\hspace{2cm}}$ number of proton and neutron in the nucleus.
- g) What are fermions ?
- h) The saturation current in the graph between voltage and current is called $\underline{\hspace{2cm}}$.

L-494

[Turn Over

[2]

- i) Give two examples of bosons.
- j) $1 \text{ a.m.u.} = \underline{\hspace{1cm}} \text{ MeV.}$
- k) Emission of α -particles reduces the atomic number by $\underline{\hspace{1cm}}$.
- l) $\underline{\hspace{1cm}}$ gas is used in G.M. Counter.

Part-II

2. Answer any *eight* of the following : 2×8

- a) Explain parity.
- b) Write four properties of α -rays.
- c) Write down the failure of liquid drop model.
- d) Write down the similarities between liquid drop model and the nucleus.
- e) Write the limitations of linear accelerator.
- f) Name two detectors based on the principle of ionisation.
- g) Write down the uses of cyclotron.
- h) Mention four characteristics of weak interactions.
- i) What is Higgs's Boson ?
- j) Write the relation between nuclear radius and atomic number.

[3]

Part-III

3. Answer any *eight* of the following : 3×8

- a) Write down the properties of nuclear forces.
- b) Explain the stability of nucleus from $N \sim Z$ graph.
- c) Write down the failures of shell model.
- d) Describe the role of neutrons for the stability of nucleus.
- e) Explain magic number with examples.
- f) Mention the basic components of Scintillation counter.
- g) What is a synchrotron ? Name the types of synchrotron used.
- h) Write down different types of particle interactions.
- i) Describe about strangeness quantum number.
- j) State and explain conservation of parity.

Part-IV

4. a) Define mass defect, binding energy. Write their expression. Draw and explain binding energy per nucleon \sim mass number graph. 7

OR

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

1. a) State and Explain Position momentum uncertainty relation. Show that the wave-packet corresponding to minimum uncertainty product is a Gaussian wave packet. 12
- b) Explain zero point Energy. 3

OR

- c) Starting from the time independent Schrodinger equation of the type $\nabla^2 \psi + \frac{\partial s}{\partial t} = 0$. Discuss the above equation physically. What will be J for $\psi = \exp[ik, r]$? Give result. 12
- d) Write down Normalisation condition. 3

[2]

2. a) Evaluate the commutator $[\hat{x}, \hat{H}]$. 5
- b) Define Energy eigen value. Explain an arbitrary wave function a linear combination of energy eigen functions. 10

OR

- c) Establish the time dependent Schrodinger equation in three dimension in the presence of forcefield. Give an account of probability interpretation of wave function. 12
- d) Prove that 3

$$[\hat{x}, \hat{p}_x] = i\hbar$$

3. a) What is a one dimensional step ? 2
- b) A particle of mass m is moving in one dimensional potential given by

$$V = \begin{cases} 0, & \text{for } x < 0 \\ V_0, & \text{for } x \geq 0 \end{cases}$$

If the energy E of the incident particle is greater than V_0 , then calculate the co-efficient of reflection and transmission. 13

OR

[3]

- c) Give the quantum mechanical treatment for one dimensional harmonic oscillator, obtain the energy levels and wave function of the oscillator. 9

d) Calculate the expectation value of potential energy in the ground state of linear harmonic oscillator. 6

4. a) Describe Stern-Garlach experiment. Discuss how it explained space quantisation and electron spin. 13

b) What is the significance of Stern-Garlach experiment result ? 2

OR

c) What is Anomalous Zeeman effect. Discuss it with reference to D_1 and D_2 lines of sodium. 3 + 6

d) Explain Paschen-Back effect. 6

L-532-250

□□

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

1. a) Find an expression for separation between lattice planes. 5
- b) Calculate atomic packing factor for SC, BCC and FCC structure. 10

OR

- c) Explain geometrical structure factor with mathematical expression. 10
 - d) How is it related to atomic scattering factor. 5
2. a) Deduce vibrational modes of a finite one-dimensional monoatomic lattice. How does this knowledge help in calculating the specific heat ? 10 + 5

OR

[2]

- b) Explain (i) Three level laser (ii) Four level laser schemes. 10
- c) Briefly describe working of a Ruby laser. 5
3. a) Describe the Langevin's theory of paramagnetism and obtain an expression for susceptibility. Comment on temperature dependence of susceptibility. 15

OR

- b) Derive Clausius Mossoti equation. 7
- c) Explain Classical Theory of electronic polarisability. 8
4. a) Discuss the function of allowed and forbidden energy bands in the basis of Kroning-Penny model. 15

OR

[3]

- b) Differentiate between type-I and type-II superconductors using Meissner effect. 5
- c) Explain Hall effect? 5
- d) Derive London equation. 5

L-559-250

□□

5. a) Prove that $\langle f_x \rangle = \frac{d}{dt} \langle P_x \rangle$ by operator method, where symbols have their usual meaning. 6

OR

- b) A and B are two Hermitian operator. Under what condition the product AB is also a Hermitian operator.

6. a) Derive general solution of Schrodinger dependent's time dependent equation in terms of linear combination of stationary state. 6

OR

- b) Show that the energy of a particle trapped in an one-dimensional box of length is

$$E_n = \frac{n^2 \hbar^2 \pi^2}{2ma^2}.$$

7. a) Write notes on the following : 6

- i) Spin Magnetic Moment
ii) Space quantisation of atom.

OR

- b) Discuss Paschen-Back effect.

L-1-1400

**2022**

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions**Part-I**

1. Answer the following : 1 × 8
- a) Does $\psi(\bar{r}, t)$ is measurable quantity ?
- b) Does spin of particle are considered for Schrodinger equation ?
- c) Write the condition for normalisation.
- d) Eigen values of Hermitian operation are _____.
- e) What is quantum dot ?
- f) When the energy E of an incident particle approaches the barrier height V_0 , the transmission probability is _____.
- g) What is nature of energy levels of an linear harmonic ascillator ?
- h) If the radius of the first Bohr orbit is 5.29 \AA , then the radius of second Bohr orbit will be _____.

L-1

[Turn Over

Part-II

2. Answer any *eight* of the following : 1½ × 8
- Define behaved wave function.
 - Explain tunneling effect.
 - Define transmission co-efficient.
 - Prove that position operator is hermitian.
 - What is normal Zeeman effect ?
 - What is energy eigen spectrum ?
 - What do you mean by stark effect ?
 - What fraction of the incident electron beam of energy 36ev will be reflected at the boundary of step potential of height 16ev ? What would be the fraction of proton beam of same energy.
 - What is the classical probability of finding the linear harmonic oscillator ?
 - What is the significance of Stern-Gerlach experimental result ?

Part-III

3. Answer any *eight* of the following : 2 × 8
- Explain zero-point energy.
 - Normalise the wave function

$$\psi(x) = Ae^{-\alpha x^2} \text{ on x-axis.}$$

- State and explain Larmor's theorem.
- Define wave packet.
- Calculate the energy difference between ground state and first excited state for an electron in 1D rigid box of length 1Å , If mass of the electron is $9.1 \times 10^{-31}\text{kg}$ and $h = 6.62 \times 10^{-34}\text{JS}$.
- Write down the importance of Quantum mechanical scattering experiment.
- What is Bohr magneton ? Write its expression.
- When does the eigen functions are orthogonal ?
- Define Gyromagnetic Ratio.
- Write down Schrodinger's time dependent equation in 3D.

Part-IV

4. a) What do you mean by probability density and current density and derive their expression by establishing equation of continuity. 6

OR

- b) Define energy eigenvalue. Explain an arbitrary wave function as a linear combination of energy eigen functions.

Part-IV

4. a) Describe X-ray diffraction. State and derive Bragg's Law of crystal diffraction. 6

OR

b) What is reciprocal Lattice ? Write its construction and properties.

5. a) Describe Langevin theory of diamagnetism. 6

OR

b) Deduce expression for heat capacity of solid at constant volume by Einstein Model.

6. a) Derive Clausius-Mosotti equation. 6

OR

b) Briefly describe working of Ruby Laser.

7. a) Discuss the formulation of London's equation and its significance. 6

OR

b) Derive Value of Hall voltage and Hall mobility.



2022

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer all questions

Part-I

1. Answer the following : 1 x 8

a) The unit cell with dimension $\alpha = \beta = \gamma = 90^\circ$, $a = b = c$ is ____.

b) Bragg's Law in terms of reciprocal Lattice vector G is $2K \cdot G + G^2 = 0$ (True/False).

c) Do phonons have a mass ?

d) Does the magnetization of paramagnetic salt depend on temperature ?

e) Electronic Polarizability of an atom is proportional to ____.

f) Can we obtain light amplification in the absence of stimulated emission ?

- g) What is the energy of the lowest energy band in Kroning Penny models if $P \ll 1$.
- h) Superconductivity was first discovered by ____.

Part-II

2. Answer any *eight* of the following : $1\frac{1}{2} \times 8$
- a) Why reciprocal Lattice is so named ?
- b) What are Bravais Lattices ?
- c) What is first Brillouin zone ?
- d) Susceptibility of a material is 21. Find its permeability.
- e) Define dielectric constant of a material.
- f) How did Debye modify the Einstein's model of specific heat ?
- g) How do you classify magnetic substance ?
- h) State whether a Laser is an amplifier or an oscillator.
- i) What is the cause of Hall Potential ?
- j) What is Meissner's effect ?

Part-III

3. Answer any *eight* of the following : 2×8
- a) What is phonon ? Give an example.
- b) Write the difference between crystalline and amorphous solid.
- c) Calculate the inter planer spacing between (2,2,0) planes of a cubic Lattices.
- d) State Curie Law. Define Curie temperature.
- e) Find the Miller indices of a set of planes parallel to z-axis having intercept in the ratio 3a : 4b on X and Y-axis.
- f) The magnetic susceptibility of a medium is 899×10^{-11} . Calculate relative permeability, absolute permeability.
- g) What is gyromagnetic orbital ratio ?
- h) Why cooling is required is Rubby Laser ?
- i) Why good conductors are not superconductor.
- j) Distinguish type-I and type-II superconductor.

[4]

V-UG-Phy(DSE)-I (NC)

Part-IV

2022

4. a) Find acceleration of the system in Atwood machine using Lagrange equation. 7

OR

Full Marks - 80
Time - 3 hours

OR

b) Find expression for generalised velocity and generalised kinetic energy.

The figures in the right-hand margin indicate marks
Answer *all* questions

Part-I

5. a) Use Hamiltonian to find equation of motion for a particle in central force field. 7

OR

b) Prove that the Geodiscs of a spherical surface are great circle, using variational method.

6. a) Derive mass energy relation. 7

OR

b) Derive $m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$, where symbols have their usual meaning.

7. a) Derive energy-momentum relation in four vector system. 7

OR

b) Discuss two body decay of unstable particles in relativistic Kinematics.

L-74-1400



L-74

[Turn over

1. Answer the following by fill in the blanks or one word answer : 1 × 12

a) Workdone by constraint forces in rigid body is _____.

b) Virtual displacement is instantaneous (True/false)

c) Write down Lagrange's is equation of motion.

d) the number of degree of freedom of a dumb bell is _____.

e) For hyperbolic orbit the value of energy is _____.

f) Write modified Hamilton's principle.

g) If potential energy function

$$V = kr^n \text{ . force } f(o) = \underline{\hspace{2cm}} \text{ .}$$

h) Form Euler Lagrange equation $\frac{\partial f}{\partial y} = \text{constant}$ if f is independent of y. (True/false).

[2]

- i) Write expression for Hamilton's principle.
- j) Moving clock appears to go _____. (slow/fast)
- k) According to Galilean Transformation time is _____. (absolute/relative)
- l) A four vector is also called _____ vector.

Part-II

2. Answer any *eight* of the following : 2×8
- a) What is light cone ?
 - b) What are constraints ?
 - c) Write D'Alembert's principle.
 - d) Explain virtual work.
 - e) What are the two condition to be satisfied ? For Hamilton's principle $\delta \int L dt = 0$.
 - f) How do constraint affect the motion of a mechanical system.
 - g) State the postulates of special theory of relativity.
 - h) How much energy is generated from 4mgm of mass ?
 - i) Explain red shift. What is its importance ?
 - j) What are the components for four acceleration ?

[3]

Part-III

3. Answer any *eight* of the following : 3×8
- a) Find the Lagrangian for a particle in plane polar coordinate.
 - b) Show that motion of a particle under central force take place in a plane.
 - c) Prove that $\frac{d}{dt} \left(\frac{\partial \bar{F}}{\partial \dot{q}_j} \right) = \frac{\partial \bar{V}}{\partial q_j}$.
 - d) Find the Hamiltonian. If the Lagrangian of a system is given as $L = ax^2 + by^2 - kxy$.
 - e) For the equation of orbit given by the conic $r = \frac{p}{1 + \epsilon \cos \theta}$. Find the law of force.
 - f) Write equations of relativistic addition of velocity.
 - g) Find the velocity of a body at which its mass increase by 20%.
 - h) What is twin paradox ?
 - i) Define phase space.
 - j) Find the velocity of 1Mev electron.

L-74

[Turn over

5. a) What do you mean by nuclear reaction ? What is Q-value of nuclear reaction. 7

OR

- b) Derive semiempirical mass formula.

6. a) Explain principle, construction and working of G.M. counter. 7

OR

- b) Describe principle construction and working of cyclotron.

7. a) What are Leptons ? Name any three leptons and their respective antileptons. 7

OR

- b) Write short notes on the following :

- i) Baryon number
ii) Quark model.

L-111-1400

2022

Full Marks - 80

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions**Part-I**

1. Answer the following by fill in the blanks or one to two words answer : 1×12
- a) How much energy is liberated from 1amu.
- b) Parity remains _____ during nuclear transformation.
- c) Curie is the unit of _____.
- d) Write the symbol of positron.
- e) Thermal neutrons are _____.
- f) The shell model fails to explain _____ value.
- g) Write two name of radiation detector.
- h) _____ defectors are based on the principle of ionisation of gas.
- i) Muon has a life time of the order of _____ sec.

L-111

[Turn over

[2]

- j) The other name of proton synchrotron is _____.
- k) Mass of neutron is _____ amu.
- l) Name the scientist who predicted meson for the nuclear force.

Part-II

2. Answer any *eight* of the following : 2×8
- a) What are drawbacks of Bohr atom model ?
 - b) In which kind of decay, parity is not conserved.
 - c) What is Geiger Nuttal law ?
 - d) Write principle of Linear accelerator.
 - e) What is threshold energy ?
 - f) Write the relation between binding energy and mass defect.
 - g) Name two detectors based on the principle of ionisation.
 - h) What is a corona discharge ?
 - i) Write the first three magic numbers.
 - j) Write are possible spin of mesons.

[3]

Part-III

3. Answer any *eight* of the following : 3×8
- a) Find binding energy of ${}^4_2\text{He}^4$.
 - b) Explain angular momentum of nucleus.
 - c) Write down the failures of shell model.
 - d) Name different types of nuclear reactions.
 - e) Which are the elements having semimagic numbers.
 - f) Explain the higher stability of even-even nuclei.
 - g) Differentiate between a cyclotron and synchrotron.
 - h) What are the disadvantages of semiconductor detector.
 - i) What is isospin of Ω baryons.
 - j) What is the neutrino hypothesis of Beta decay ?

Part-IV

4. a) Explain the proton-electron theory of the nucleus. 7

OR

- b) Write short notes on the following :
- i) N/A plot
 - ii) Gamma decay.

L-111

[Turn over

MODEL QUESTION

(SOLID STATE PHYSICS)

- The ratio of the second-neighbour distance to the nearest-neighbour distance in an fcc lattice is
 - $2\sqrt{2}$
 - 2
 - $\sqrt{3}$
 - $\sqrt{2}$
- Monochromatic X-rays of wavelength 1\AA are incident on a simple cubic crystal. The first order Bragg reflection from (311) plane occurs at angle of 30° from the plane. The lattice parameter of the crystal in \AA is
 - 1
 - $\sqrt{3}$
 - $\sqrt{11/2}$
 - $\sqrt{11}$
- A plane in a cubic lattice makes intercepts of a , $a/2$ & $2a/3$ crystallographic axes, respectively. The Miller indices for this plane are:
 - (2 4 3)**
 - (3 4 2)
 - (6 3 4)
 - (1 2 3)
- In a pn junction, dopant concentration on the p-side is higher than that on the n-side. Which of the following statements is (are) correct, when the junction is unbiased?
 - The width of the depletion layer is larger on the n-side.**
 - At thermal equilibrium the Fermi energy is higher on the p-side.
 - In the depletion region, number of negative charges per unit area on the p-side is equal to number of positive charges per unit area on the n-side**
 - The value of the built-in potential barrier depends on the dopant concentration.**
- Which of the combinations of crystal structure and their coordination number is (are) correct?
 - body centered cubic- 8**
 - face centred cubic- 6
 - Diamond- 4**
 - Hexagonal closed packed- 12**
- Which of the following statements is correct for NaCl crystal structure?
 - It is simple cubic lattice with one atom basis
 - It is a face-centered cubic lattice with one atom basis
 - It is a simple cubic lattice with two atom basis
 - It is a face-centered cubic lattice with two atom basis**

7. In a crystalline solid, the energy band structure (E vs k relation) for an electron of mass m is given by $\frac{\hbar^2 k(2k-3)}{2m}$. The effective mass of the electron in the crystal is
- m
 - $2m/3$
 - $m/2$
 - $2m$
8. The fraction of volume unoccupied in the unit cell of the body centered cubic lattice is
- $\frac{8-\sqrt{3}\pi}{8}$
 - $\frac{\sqrt{3}\pi}{8}$
 - $\frac{6-\sqrt{2}\pi}{6}$
 - $\frac{\pi}{3\sqrt{2}}$
9. Diamond lattice can be considered as a combination of two fcc lattice displaced along the body diagonal by one quarter of its length. There are eight atoms per unit cell. The packing fraction of the diamond structure is
- 0.48
 - 0.74
 - 0.34
 - 0.68
10. Miller indices of a plane in cubic structure that contains all the directions $[100]$, $[011]$, $[\bar{1}\bar{1}\bar{1}]$ are
- (011)
 - (100)
 - (101)
 - (110)

MODELQUESTION

Full marks-

60Time-

3hours

Answer all the

questionsPart-I

[1x8]

1. Answer the following questions

- Virtual displacement is imagined and infinitesimal(true/false)
- What is the number of degree of freedom of free particle?
- Brachistochrone is the curve of _____ descent.
- For hyperbolic orbit the value of energy is _____.
- Inertial frame of reference are accelerated (true/false)
- Simultaneities is a _____ concepts, but not absolute.
- The space part of four momentum is _____.
- A four vector is also called _____ vector.

PART-II

[1.5x8]

2. Answer any 8 of the following questions.

- On what factors does Lagrangian of a system depends?
- What is reversed effective force?
- Write the expression for canonical momentum?
- For linear force $F=-kr$, what is the expression for potential energy(V)?
- Find the rest energy of electron in MeV?
- Find the fractional increase in mass of a particle moving with velocity $0.1c$.
- Write two expressions for energy momentum four vectors.
- What do you mean by conservation of four momentum.

3. Answer any 8 of the following questions.[2x8]

- The length of a rocket ship is 100m .With what velocity should it move so that its length appears to be 99m.
- Obtain the relation $E^2=P^2C^2+m^2 C^4$
- Write the expression for Hamiltonian of one dimensional oscillators.
- Discuss the advantages of D'Alembert's principle.
- Find the Lagrangian of free particle of mass m moving in space.
- Explain virtual work.
- Find the energy needed to give an electron a speed of $0.8c$ starting from rest?
- Using 4 vector method show that a massive particle cannot decay into photon?
- Is $\gamma \rightarrow e^+ + e^-$ possible in free space?
- Under what condition the space time interval is said to be light like?

PART-IV

Answer all the following questions.

[6x4]

4. Derive Lagrangian's equation of motion for non-conservative system using D'Alembert's principle.

Or

Derive equation of motion for coupled oscillators using Lagrange's method.

5. Derive Euler-Lagrangian differential equation.

Or

Prove that the Geodesics of a spherical surface are great circles, using variational method.

6. Show that the D'Alembertian operator is invariant under Lorentz transformation.

Or

Derive Lorentz transformation equations using four vectors.

7. Derive relativistic equation of Doppler effect using four vector method. Explain red shifts and blue shifts.

Or

What do you mean by space like, time like, light like intervals? discuss.

MODELQUESTION

Full marks-

60Time-

3hours

Answer all the

questionsPart-I

1. Answer the following questions

[1x8]

- Who postulated spin orbit coupling interaction?
- What is limited proportionality region?
- Is graviton a massless boson?
- What is the isospin of K-meson?
- Write the expression for hypercharge in terms of isospin.
- What is quenching?
- Name a device which is an application of ionization chamber.
- What is dead time in G.M. counter?

PART-II

2. Answer any 8 of the following questions.

[1.5x8]

- Calculate the binding energy of deuteron ?
- What is nuclear spin?
- Explain pair production in liquid drop model.
- What is magic number?
- What is endoergic and exoergic nuclear reaction?
- What are fermions?
- What is the principle of synchrocyclotron?
- Explain Geiger-Muller region.

3. Answer any 8 of the following questions. [2x8]

- Define electric and electric quadrupole moment.
- Write the limitations of liquid drop model.
- State the laws of radioactive disintegration.
- Discuss the advantages of semiconductor diode.
- How the order of maximum energy achieved by charged particles by LINAC.
- Compare composite Boson and Mesons.
- Define hypercharge and strangeness.
- Write the expression for Threshold energy.
- What do you understand by Q-value of a nuclear reaction.
- Explain neutrino hypothesis.

PART-IV

Answer all the following questions.

[6x4]

4. Explain the proton electron theory of structure of nucleus . show that electron cannot exist inside the nucleus.

Or

Explain α -decay. Give Gamow's theory of α -decay.

5. Give silent feature of nuclear shell model.

Or

Derive semi-empirical mass formula. Explain the significance of various terms.

6. Write (i) neutron detector (ii) photomultiplier tube

Or

Discuss the working and principle of cyclotron.

7. Explain the concepts of generation of Quarks and gluons.

Or

Name the four fundamental interactions and explain each of them.