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 operater ? 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 magnetion is ____ .

   h) What is Zeeman effect ?

Part-II

2. Answer any ***eight*** of the following : $1\frac{1}{2} \times 8$

   a) State super position principle.

   b) Explain probability current density.

c) Find $[x_1 P_x]$

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 $H = \frac{p^2}{2m} + \frac{1}{2} w^2 x^2$.

f) Calculate the ground state energy for a particle of mass 10g moving in a box of length 10cm.

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 $m_e = q.1\times10^{-31}kg$

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 $[\hat{P}, \hat{Q}^n] = n\hat{Q}^{n-1}[\hat{P}, \hat{Q}]$

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.

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2021

Full Marks - 60

Time - 3 hours

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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 semiconduction ?

   h) Define super conductivity.

Part-II

2. Answer any ***eight*** of the following : $1\frac{1}{2} \times 8$

   a) Define miller indices.

   b) Distinguish between crystalline and amorphous solids.

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.

d) Draw B ~ 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 numberically 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 wat of solid. 6

OR

b) Describe Largevin theory of paramagnetism.

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 co-efficients.

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

OR

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

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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 Hamiltomian 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.

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 Brachiostochrone.

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 $\theta = 0°$.

j) Write expression for momentum four vector.

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 Lagangian 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 dxdydzdt is invariant under Lorentz transformation.

i) Discuss transverse Doppler's effect.

j) Explain Light like intervals.

Part-IV

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

OR

b) What is a compound pendulum ? Derive Lagarange'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.

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2021

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) The expression for binding energy, E = ____.

   b) Name the radioactive ray which is not deflected by electric and magnetic field.

   c) The shell model fails to explain ____ values.

   d) Write expression for maximum value of pulse height.

   e) In liquid drop model, nuclear forces are analogous to ____ of liquid.

   f) The asymmetry energy arises due to ____ 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 ____.

i) Give two examples of bosons.

j) 1a.m.u. = ___MeV.

k) Emission of α-particles reduces the atomic number by ___.

l) ___ 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 Higg's Boson ?

j) Write the relation between nuclear radius and atomic number.

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 ~ 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 strengeness 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 ~ mass number graph. 7

OR

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 G.M. counter. 7

OR

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

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

OR

b) Write short notes on the following :

i) Quarks

ii) Gluons.

2019

Full Marks - 40

Time - 2 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

1. a) Give a brief explanation of different types of renewable energy sources and what are the advantages over non-renewable energy sources. 12

b) i) Discuss an overview of developments in off shore wind energy. 4

ii) What is wave energy system ? How wave energy generates electricity ? 4

OR

c) What is solar energy ? How do solar photovoltaic panels work and are they really as efficient as everyone says ? 3 + 6 + 3

d) i) How much space will a solar photovoltaic system require ? Give a quantitative analysis. 4

ii) Write a short note on Sun tracking system. 4

2. a) How wind energy harvesting as a reliable resources of energy ? Give the principle and construction of $3 + 3 + 3 + 3$

i) Wind turbines

ii) power electronic interfaces and

iii) Grid interconnection to pologies.

b) i) Write short notes on Geothermal Technologies. 4

ii) What are the environmental impact of hydropower sources ? 4

OR

c) Discuss the principle of ocean thermal energy conversion and ocean energy potential agianst wind and solar. Briefly explain wave characteristics and statistics. 4 + 4 + 4

d) i) Write short notes on Ocean Bio-mass. 4

ii) What are basic principles behind tidal energy techonologies. 4