Seat No.		**Set**	**P**

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Mathematical Physics (MSC10101)

Day & Date: Wednesday, 19-07-2023   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
      2) Attempt any three questions from Q. No. 3 to Q. No. 7.
      3) Figure to right indicate full marks.

Q.1 A) Choose correct alternatives.   **10**

1) A point at which a Function $f(z)$ is not analytic is known as a _____ or singularity of the Function.
  a) Scalar point   b) Singular point
  c) Non - Singular   d) None of these

2) In Cauchy's Residue theorem $\oint_\Gamma f(z)dz =$ _____.
  a) $2\pi i \sum_{j=1}^{n} a - 1z_j$ b) $2\pi i$
  c) $2\pi i \sum_{j=1}^{n}$ d) $2\pi i \sum_{j=1}^{n} a + 1 z_j$

3) In complex variable theory $\int_c f(z)/dz$ is called a _____ of $f(z)$ along the contour c from $Z_0 \ to \ Z'$.
  a) Contour integral   b) Residue
  c) Contour   d) None of these

4) What are the eigen value of $\begin{pmatrix} 1 & -i \\ i & 1 \end{pmatrix}$?
  a) Both are 0 b) 0 and 1
  c) 0 and -1 d) 0 and 2

5) If A, B and C are non-zero Hermitian operator which of the following relations must be false?
  a) $[A,B] = C$ b) $AB + BA = C$
  c) $A B A = C$ d) $A + B = C$

6) Which of the following is on even function of t?
  a) $t^2 - 4t$ b) $t^3 + 6$
  c) t^2 d) $\sin(2t) + 3t$

7) The degree of $x\frac{d^2y}{dx^2} + \sin\frac{dy}{dx} = 0$ is _____.
  a) 1 b) 2
  c) 3 d) Not defined

8) A square matrix, conjugate transpose of which coincide with the matrix itself is called _____.
  a) Unitary   b) Hermitian
  c) Orthogonal   d) Skew Hermitian

9) Laplace transform of $f(t)$ is defined for _____.
   a) +ve value of t b)   -ve value of t
   c) Both +ve & -ve value of t d)   None of these

10) A square matrix A is idempotent if _____.
   a) $A' = A$ b) $A' = -A$
   c) $A^2 = A$ d) $A^2 = A^2$

B) **State true or false.**   **06**
   1) A square matrix is called orthogonal if $A = A^{-1}$.
   2) The function $|\bar{z}|^2$ is not analytic at any point.
   3) $x\frac{\partial u}{\partial x} + t\frac{\partial u}{\partial t} = 2u$ is an ordinary differential equation
   4) The Function $y = 0$ is always a solution to a linear homogeneous ordinary differential equation.
   5) If $y(x)$ is solution to an nth order ODE and contain arbitrary constant, then it must be the general solution to the ODE.
   6) In matrix with 9 elements then the possible ordered pair are (3,3) (1,9) (9,1)

Q.2   Answer the following   **16**
   a) Show that any square matrix can be expressed as the sum of two matrices, one symmetric and the other antisymmetric.
   b) Solve $(1 + e^{x/y})dx + e^{x/y}(1 - x/y)dy = 0$
   c) Find the poles of $f(z) = \frac{\sin(z-a)}{(z-a)4}$
   d) Verify that :
   $A = \frac{1}{3}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ -2 & 2 & -1 \end{bmatrix}$ is orthogonal

Q.3   Answer the following.
   a) Show that the transformation   **08**
   $y_1 = 2x_1 + x_2 + x_3, \quad y_2 = x_1 + x_2 + 2x_3, \quad y_3 = x_1 - 2x_3$ is regular, write down the inverse transformation.
   b) Expand the function in square wave $f(x) = 0;\ -\pi \le x \le 0$ **08**
   $f(x) = h;\ 0 \le x \le \pi$ Fourier series

Q.4   Answer the following.
   a) Show that the eigen value of Hermitian matrix are real.   **08**
   b) Evaluate the integral $\int_0^{2\pi} \frac{d\theta}{5 - 3\cos\theta}$ **08**

Q.5   Answer the following.
   a) Explain Gaussian distribution function with example.   **08**
   b) Explain the first order linear differential equation.   **08**

Q.6   Answer the following.
   a) Use Residue calculus to evaluate the following integral.   **08**
   $\int_0^{2\pi} \frac{1}{5 - 4\sin\theta} d\theta$
   b) Solve $y'' - 2y' + y = 2\cos x$ by use of successive integration. **08**

Q.7 Answer the following.
  a) Explain the details of Parseval Theorem.   **08**
  b) Explain Laplace transform of Derivatives.   **08**

Seat No.

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Solid State Physics (MSC10102)

Day & Date: Thursday, 20-07-2023　　　　　　　　　　Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
　　　　　　　　2) Attempt any three questions from Q. No. 3 to Q. No. 7
　　　　　　　　3) Figure to right indicate full marks.

Q.1　A)　Fill in the blanks by choosing correct alternatives given below.　　10

1) Packing fraction of BCC is _____.
　a)　74%　　　　　　　　　　b)　68%
　c)　52%　　　　　　　　　　d)　58%

2) Miller indices of a plane parallel to X and Z axes are _____.
　a)　(001)　　　　　　　　　b)　(100)
　c)　(010)　　　　　　　　　d)　(101)

3) Intrinsic concentration of charge carriers in a semiconductor varies as _____.
　a)　T　　　　　　　　　　b)　T^2
　c)　T^3　　　　　　　　　d)　T^{-1}

4) What is relative permittivity?
　a)　Equal to the absolute permittivity
　b)　Ratio of actual permittivity to absolute permittivity
　c)　Ratio of absolute permittivity to actual permittivity
　d)　Equal to the actual permittivity

5) Which crystal structure has the maximum packing fraction?
　a)　BCC　　　　　　　　　　b)　HCP
　c)　FCC　　　　　　　　　　d)　both FCC and HCP

6) The superconducting state is perfect _____ in nature.
　a)　Diamagnetic　　　　　　b)　Paramagnetic
　c)　Ferromagnetic　　　　　d)　None of these

7) Below transition temperature, the London penetration depth.
　a)　Almost constant　　　　b)　Increases exponentially
　c)　Decreases exponentially　d)　None

8) Which one of the following is an application for a hall effect sensor?
　a)　Position sensing　　　　b)　DC transformer
　c)　Automatic fuel level indicator　d)　All of these

9) Phonon is Quantum of _____.
　a)　Longitudinal wave　　　b)　Elastic wave
　c)　Transverse wave　　　　d)　Electromagnetic wave

10) Why is water used in automobiles as a coolant?
　a)　It is not toxic to the environment
　b)　It has a high specific heat capacity
　c)　It has a high lubricating property which in turn keeps the engine cool by reducing friction
　d)　It is available in abundance

B) Write True or False 06
1) Rectifier rectifies internal resistance.
2) Fermi energy level in the case of a p-type semiconductor is close to the conduction band.
3) Superconductor is ferromagnetic.
4) X-rays are more visible than lasers.
5) For type I superconductors, the surface energy is always positive.
6) Insulators have a negative temperature coefficient of resistance.

Q.2 Answer the following 16
a) What is Meissner's effect?
b) Explain the BCC structure.
c) Type I and type II superconductors.
d) Direct and Indirect bandgap semiconductors.

Q.3 Answer the following
a) What is a superconductor? Write the London equations. 08
b) Write the Clausius - Mosotti equation. 08

Q.4 Answer the following
a) What is dielectric polarization? Give the expression for orientational polarization. 08
b) Write about Josephson tunneling. 08

Q.5 Answer the following
a) What is the internal field? Write the expression of the internal field. 08
b) Explain the geometrical construction of Brillion Zones in 2D. 08

Q.6 Answer the following
a) Write about the behavior of electrons in a periodic potential. 08
b) What is the Hall effect? Write about the expression for the mobility of the charge carriers. 08

Q.7 Answer the following
a) Write about the thermodynamics of a superconductor. 08
b) Write about carrier concentration in an intrinsic semiconductor. 08

Seat No.

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Analog and Digital Electronics (MSC10103)

Day & Date: Friday, 21-07-2023　　　　　　　　　　　　　Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
　　　　　　　　 2) Attempt any three questions from Q. No. 3 to Q. No. 7.
　　　　　　　　 3) Figure to right indicate full marks.

Q.1　A)　Select Correct Alternatives.　　　　　　　　　　　　　　　　10

1) _____ signal is used to demultiplex address/ data bus in 8085 microprocessors.
   a) RD　　　　　　　　　　　b) WR
   c) ALE　　　　　　　　　　 d) INTR

2) Decade counter requires _____ number of flip flops.
   a) 3　　　　　　　　　　　　b) 5
   c) 4　　　　　　　　　　　　d) 2

3) Symbolic address in microprocessors is recorded in the _____ field.
   a) Label　　　　　　　　　　b) Opcode
   c) Operand　　　　　　　　　d) Comment

4) Op-Amp is _____ coupled voltage type of amplifier.
   a) AC　　　　　　　　　　　b) DC
   c) ADC　　　　　　　　　　 d) DAC

5) The decrease in the frequency makes the phase-shift _____ in the Wien bridge oscillator.
   a) Lead　　　　　　　　　　b) Lag
   c) Lead-Lag　　　　　　　　d) None of the above

6) The NOR gate output will be high if the two inputs are _____.
   a) 00　　　　　　　　　　　b) 01
   c) 10　　　　　　　　　　　d) 11

7) The output of a particular Op-amp increases 8V in $12\mu s$. The slew rate is _____.
   a) $90\ \mathrm{V/\mu s}$　　　　　　　b) $0.67\ \mathrm{V/\mu s}$
   c) $1.5\ \mathrm{V/\mu s}$　　　　　　d) None of these

8) The no-change conditions occur when _____ in JK flip flop.
   a) J=1, K=1　　　　　　　　b) J=0, K=0
   c) J=1, K=0　　　　　　　　d) J=0, K=1

9) The output impedance of Op amp is decreases due to _____ feedback.
   a) Negative　　　　　　　　b) Positive
   c) Negative + Positive　　　d) None on these

10) The _____ gates are mainly used for checking parity of data.
    a) NOR　　　　　　　　　　b) NAND
    c) EX-OR　　　　　　　　　d) EX-NOR

B) **Fill in the blanks /State True or False.** 06
1) In JK flip flop race around condition arises due to _____.
2) A demultiplexer is used to perform _____ conversion.
3) In the oscillator circuit the total phase shift of the loop gain must be _____.
4) Negative feedback is used in oscillator circuits. (True/False)
5) The sawtooth waveform has a rise time many times than the fall time. (True/False)
6) An ideal operational amplifier has infinite input impedance. (True/False)

Q.2 **Attempt following.** 16
a) RS Flip flop.
b) Addressing modes of 8085 microprocessor.
c) Op Amp as Comparator
d) Adjustable voltage regulators.

Q.3 **a)** Write an ALP with flow diagram for addition of two 8 bit numbers using 8085 Microprocessor Immediate addressing mode. 10
b) Reduce the following logical expressions using Boolean laws: 06
$(\overline{A}B + AB)(\overline{A}BC + ABC)$
Draw logic diagram of reduced expression.

Q.4 **a)** What is shift register? Draw and explain logic diagram of PIPO shift register. 10
b) Draw and explain 8:1 multiplexer using AND gate. 06

Q.5 **a)** Describe Non-inverting configuration of 3 input Op Amp as a summing. Scaling and averaging amplifier. 10
b) Elucidate effect of negative feedback on output resistance of Op Amp. 06

Q.6 **a)** Describe functional block diagram of Intel 8085 microprocessor. 10
b) Demultiplexing of AD0- AD7 signals. 06

Q.7 **a)** What is Oscillator? Describe phase shift oscillator, obtain an expression for frequency of oscillation. 10
b) Design a phase shift oscillator for f_0=1 KHz, using IC741. 06
(Supply voltage = $\pm15V$)

| Seat No. | | Set | P |

M.Sc. (Semester - I) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Classical Mechanics (MSC10108)

Day & Date: Saturday, 22-07-2023   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question Nos.1 and 2 are compulsory.
　　　　　　　2) Attempt any three questions from Q. No. 3 to Q. No. 7.
　　　　　　　3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternatives from the options.   **10**

1) The energy of a particle of mass M and E its momentum is p, then the relation between E and P is _____.
   a) $E = \dfrac{P}{2M}$ b) $E = \sqrt{2PM}$
   c) $P = \sqrt{2\,ME}$ d) $P = \dfrac{2M}{E}$

2) The path of the particle is _____ when it is moving under the constant conservative force field.
   a) Cycloid   b) Hyperbolic
   c) Parabolic   d) straight line

3) The reduced mass μ = _____.
   a) $(m_1 + m_2)/m_1 m_2$ b) $m_1 m_2/(m_1 - m_2)$
   c) $m_1 m_2/(m_1 + m_2)$ d) $(m_1 - m_2)/m_1 m_2$

4) In equations of motion $\dot{P}_j$ = _____.
   a) $-\partial H/\partial P_j$ b) $\partial H/\partial P_j$
   c) $\partial H/\partial q_j$ d) $-\partial H/\partial q_j$

5) If eccentricity $\epsilon = 1$, then the shape of the orbit, which is formed due to motion under central force field will be_____.
   a) Ellipse   b) Circle
   c) Hyperbola   d) Parabola

6) [u, vw] = _____.
   a) [u, v]w + v[u, w]   b) [u, w]v + [w, u]v
   c) [u, v]w + [v, w]u   d) [u, v]w + v[w, u]

7) The generating function $F_1(q, Q, t)$ generates _____ transformations.
   a) Exchange   b) Identity
   c) None   d) infinite

8) The Phase space is _____ dimensional space.
   a) 3N   b) 2N
   c) 6N   d) N

9) The Poisson bracket of [u, p$_j$] = _____.
   a) $-\partial u/\partial p_j$ b) $\partial u/\partial q_j$
   c) $+\partial u/\partial p_j$ d) $-\partial u/\partial q_j$

10) The point transformation is the transformations of _____.
   a) Phase space
   b) configuration space
   c) both a & b
   d) point space

B) State True or False: 06
   1) The Poisson bracket of [u,c] = u where c is constant.
   2) The areal velocity of the particle in a central force field is zero.
   3) The Poisson bracket of the function with itself is zero.
   4) Newtonian mechanics is based on the concept of Force.
   5) In Phase space, the system is having a unique path.
   6) Lagrangian is based on the function L=T+V

Q.2 Answer the following. 16
   a) Write note on Rutherford's scattering.
   b) The particle describes a circular orbit given by r = 2a cos θ under the influence of an attractive central force. Show that the force varies as inverse 5th power of the distance.
   c) State the variational principle and derive Hamilton's canonical equations using the variational principle.
   d) Explain the work-energy theorem in brief.

Q.3 Answer the following.
   a) What is meant by real and pseudo forces? Give an example of each. Show that the angular acceleration is the same in fixed and rotating frames. 10
   b) State and explain the laws of conservation of linear momentum & angular momentum of a single particle system. 06

Q.4 Answer the following.
   a) What are the main features of the motion of a particle under the action of central force? Show that the area swept per unit time i.e. dA/dt remains constant in such a motion. 10
   b) Distinguish between the configuration space and phase space. 06

Q.5 Answer the following.
   a) What is Poisson Bracket? List its properties. Explain Jacobi's identity with its proof. 10
   b) Show that the transformation $Q = 2q^{1/2} e^{a} \cos p$ and $P = (2q)^{1/2} e^{-a} \sin p$ is canonical. 06

Q.6 Answer the following.
   a) Explain the term differential scattering cross section and derive the formula for the same. 10
   b) Write a note on Hamilton's - Jacobi Theory. 06

Q.7 Answer the following.
   a) Show that the generating function $F = \sum q_k Q_k$ produces exchange Transformation. 10
   b) Explain the different shapes of orbits formed due to motion under a central force field. 06

Seat No.

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLIDSTATE PHYSICS)
Quantum Mechanics (MSC10201)

Day & Date: Wednesday, 19-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7
3) Figure to right indicate full marks.

Q.1 A) Fill in the blanks by choosing correct alternative.   **10**

1) If Ψ be a complex function, then $\Psi^*\Psi$ must vanish at _____.
   a) unity   b) zero
   c) infinity   d) finite value

2) Momentum of particle by de-Broglie relation is _____ to its wavelength.
   a) Inversely proportional   b) directly proportional
   c) in phase   d) out of phase

3) The energy spectrum of a particle in one-dimensional rigid box has the nature of _____
   a) infinite sequence of discrete energy levels
   b) exponentially increasing
   c) infinite sequence of equidistant energy levels
   d) exponentially decreasing

4) The eigen value of the energy of a particle in a cubical box is $11(h^2/8ma^2)$. The quantum numbers of the state are _____.
   a) (311)   b) (301)
   c) (222)   d) (111)

5) Potential energy of a particle in harmonic oscillator having mass m is _____.
   a) $m\omega^2 x^2$ b) $(1/2)m\omega^2 x^2$
   c) $mr\omega^2$ d) $(1/2)mv^2$

6) The eigen value of spin matrices are _____
   a) ±2   b) 0
   c) ± 1   d) ∞

7) The commutation relation between L^2 and L_x i.e. $[L^2, L_x]$ = _____.
   a) 0   b) 1
   c) ∞   d) 2

8) The outer product of bra and ket function is called _____ operator.
   a) state   b) unitary
   c) energy   d) identity

9) In operator equation $H\psi = E\psi$ the eigen function is _____.
   a) H b) ψ
   c) E d) H & E

10) Raising operator is defined as _____.
   a) $L_x + iL_y$ b) $L_x - iL_y$
   c) $iL_z - L_y$ d) $iL_x - iL_z$

B) Fill in the blanks or Write true /false 06
   1) The Heisenberg's uncertainty principle is applicable to all conjugate pair of variables. (True/False)
   2) Einstein photoelectric and Compton effects are the evidence of wave nature of matter. (True/False)
   3) Probability density is always positive. (True/False)
   4) The magnitude of total angular momentum is _____.
   5) The lowest energy of an harmonic oscillator is obtained by putting n equal to _____.
   6) The energy operator is given by _____.

Q.2 Answer the following 16
   a) Find the lowest energy of an electron confined to move in a one-dimensional box of length 2 Å? Given: $m = 9.11 \times 10^{-31}\, kg,\ \hbar = 1.054 \times 10^{-34}\, J-s$
   b) Explain Pauli spin matrices.
   c) What is WKB method? Elaborate.
   d) Describe the wave packet.

Q.3 Answer the following
   a) Discuss eigen values and eigen functions for a particle in three-dimensional infinite potential well. 08
   b) Discuss wave-functions or eigen functions of linear harmonic oscillator and give their physical interpretation. 08

Q.4 Answer the following
   a) Elaborate the uncertainty relation. 08
   b) Explain Dirac's bra-ket notation. 08

Q.5 Answer the following.
   a) Write the interpretation and properties of wave function. What is admissible wave function? 08
   b) What is Ehrenfest's theorem? Prove it. 08

Q.6 Answer the following.
   a) Explain in detail about the variational and WKB methods with simple examples. 08
   b) Write down the matrices for J², Jx, Jy and Jz operators. 08

Q.7 Answer the following.
   a) What are equations of motion? Explain the Schrodinger, Heisenberg and Interaction pictures. 08
   b) Describe the box normalization and Dirac Delta function. 08

Seat No.	

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Electrodynamics (MSC10202)

Day & Date: Sunday, 23-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
                        2) Attempt any three questions from Q. No. 3 to Q. No. 7
                        3) Figure to right indicate full marks.

Q.1   A)   Fill in the blanks by choosing correct alternatives given below.   10
1)   Indicates that _____.
   a)   Non-existance of magnetic dipole
   b)   Non-existance of magnetic monopole
   c)   Existance of magnetic monopole
   d)   Existance of electric monopole

2)   In vacuum divegence of electric field over a surface is _____.
   a)   zero   b)   charge enclosed by surface
   c)   one   d)   none of above

3)   Faradays law shows that a changing magnetic field gives rise to _____.
   a)   electric field   b)   magnetic force
   c)   lorentz force   d)   none of above is correct

4)   In free space the value of E, the electric field vector at any instant is _____ time the value of H, the magnetic field vector.
   a)   277   b)   577
   c)   477   d)   377

5)   The normal component of magnetic field, above and below the surface _____.
   a)   discontinuous   b)   continuous
   c)   different   d)   independent of charges

6)   The electric field inside a conductor is _____.
   a)   Greater than zero   b)   Less than zero
   c)   Zero   d)   none of these

7)   The energy in magnetic field is proportional to _____.
   a)   Square of magnetic field   b)   Square root of magnetic field
   c)   Square of electric field   d)   Square root of electric field

8)   The radiation from an oscillating electric dipole is generally _____.
   a)   Transverse electric   b)   Zero
   c)   Positive   d)   Transverse magnetic

9)   The vector potential is, due to _____.
   a)   Charge density   b)   Surface charge
   c)   Charge   d)   Current density

10) Two particles with identical charges and mass collide, there is _____.
   a)   Radiation   b)   No radiation
   c)   Retardation   d)   None of these

B) **Fill in the blanks OR Write true/false** 06
1) The parallel component of electric field, above and below the surface _____.
2) The angular distribution of radiation for accelerating particle is _____ direction.
3) As in electrostatics then $E =$ _____.
4) In a monochromatic plane wave in free space, E and B at any instant _____.
5) The Lorentz force under electric and magnetic field is given by _____.
6) For normal incidence of EM wave at interface of two media having refractive indices $n_1 = n_2$ then _____.

Q.2 **Answer the following** 16
a) Write the Maxwell's equations in integral form.
b) Define and explain Biot-Savart law.
c) State and prove Gauss's law.
d) Prove that magnetic force do no work on particle.

Q.3 **Answer the following**
a) Show that vector potential for dipole is $A_{dip} = \frac{\mu_0}{4\pi} \frac{m \times \hat{r}}{r^2}$. 10
b) Derive and show that the electric field is the gradient of a scalar potential. 06

Q.4 **Answer the following**
a) Solve for static magnetic field. 10
b) Discuss magneto static boundary conditions in detail. 06

Q.5 **Answer the following**
a) State and prove Poyntings theorem. 08
b) Explain skin effect and skin depth. 08

Q.6 **Answer the following**
a) Obtain the Fresnel's relation for the polarization perpendicular to the plane of incidence. 08
b) Obtain plane wave equation of electromagnetic field in vacuum. 08

Q.7 **Answer the following**
a) What is radiation from half wave antenna and explain it. 08
b) Explain the concept of radiation damping. 08

Seat No.	

M.Sc. (Semester - II) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Statistical Physics(MSC10206)

Day & Date: Tuesday, 25-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Question 1and 2 are compulsory.
                 2) Attempt any Three from Q.3 to Q.7.
                 3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative.   **10**

1) In which thermodynamics process, there is no flow of heat between the system and its surroundings?
   a) isothermal   b) isochoric
   c) isobaric   d) adiabatic

2) In a micro-canonical ensemble, the system exchange.
   a) only matter   b) only energy
   c) both energy and matter   d) neither energy nor matter

3) It never happens that heat by itself flows from ____ body to a ____ body.
   a) cold, cold   b) hot, cold
   c) cold, hot   d) hot, hot

4) The equation of state for an ideal gas is represented as _____.
   a) $PV = R/T$ b) $PV = nRT$
   c) $P/V = R/T$ d) $PV = RT$

5) The heat or energy consumed or emitted during a phase change of a material is known as _____.
   a) latent heat   b) specific heat
   c) phase heat   d) none of the above

6) Entropy in thermodynamics is a measure of _____.
   a) order of system   b) pressure of the system
   c) volume of system   d) disorder of the system

7) The value of the universal gas constant is _____.
   a) 8.2353   b) 8.3143
   c) 8.5123   d) 8.2352

8) Phase equilibrium curve terminates at _____.
   a) boiling point   b) sublimation point
   c) triple point   d) critical point

9) Louisville's equation gives the rate of change in
   a) pressure   b) temperature
   c) density   d) volume

10) Which of the following statement is correct for the perfect black body?
  a) It can transmit entire radiation incidents on it
  b) It can absorb entire radiation incidents on it
  c) The emissive power of the black body is less than an ordinary body
  d) All the above statements are correct for the black body.

B) Fill in the blanks or write true/ false.   **06**
  1) Gibb's free energy determines The relative stability of a system for transformation at constant temperature and pressure.
  2) Photon, Phonon, etc. obeys the Fermi Dirac distribution function.
  3) In a microcanonical ensemble both energy and mass are conserved.
  4) Louisville's equation gives the rate of change in pressure.
  5) The unit of mass in the S.I. unit is _____.
  6) Entropy is a _____ function.

Q.2 Answer the following (any four)   **16**
  a) Calculate the increase in entropy when 746 gm of water is converted into vapor at 100°C. The latent heat of vaporization of water = 540 Cal/ gm.
  b) How the properties of matter change near the triple point.
  c) Write a note on grand canonical ensembles.
  d) Explain the difference between microstates and macrostates.
  e) Write a note on a PT diagram.

Q.3 Answer the following.
  a) State thermodynamic potential and Maxwell's equations.   **10**
  b) Explain the concept of statistical equilibrium.   **06**

Q.4 Answer the following.
  a) Explain the 2nd order phase transition phenomenon with on example.   **08**
  b) Derive Ehrenfest equations.   **08**

Q.5 Answer the following.
  a) Give the condition for B E condensation.   **10**
  b) By using the Vander Waals equation at reduced states calculate the values of critical constants.   **06**

Q.6 Answer the following.
  a) What is the Gibbs paradox and how it is resolved?   **10**
  b) Write a note on black body radiations.   **06**

Q.7 Answer the following.
  a) Derive Clausius Clapeyron equation.   **10**
  b) Obtain Plank's law for black body radiation.   **06**

SLR-SU-10

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Set **P**

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Semiconductor Physics (MSC10301)

Day & Date: Monday, 10-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. No. 1 & 2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) Figures to the right indicate full marks.

Q.1 A) Choose correct alternatives. 10

1) P-type semiconductor the Fermi energy level is _____.
   a) Near the conduction band   b) Near the valance band
   c) at the center   d) not available

2) In semiconductors the motion of the charge carrier under the influence of the _____ is called as drift.
   a) electric field   b) magnetic field
   c) gravitational field   d) None of these

3) In intrinsic semiconductor the Fermi energy level is _____.
   a) Near the conduction band   b) Near the valance band
   c) At the center   d) Not available

4) The depletion region is created by _____.
   a) Ionization   b) Diffusion
   c) Recombination   d) All of these

5) Molecular Beam Epitaxy is a _____ process.
   a) Physical vapor deposition
   b) Chemical vapor deposition
   c) Chemical bath deposition
   d) Hydrothermal deposition

6) The equilibrium number of electron-hole pairs in pure Si at room temperature is _____.
   a) 10^{10} EHP/m^3 b) 10^{12} EHP/cm^3
   c) 10^{10} EHP/cm^3 d) 10^{12} EHP/m^3

7) What is the role of seed crystal in crystal growth?
   a) Nucleation center   b) Catalyst
   c) Solvent   d) Solution

8) The shape of E-K diagram of the conduction band and valance band is _____.
   a) Horizontal   b) Vertical
   c) Parabolic   d) Elliptical

9) The conductivity of a sample due to excess carriers created by phonon vibration is called _____.
a) Thermal conductivity
b) Electrical conductivity
c) Photoconductivity
d) None of these

10) At the absolute zero temperature ($-273°$ C), an intrinsic semiconductor has _____
a) A few free electrons
b) Many Holes
c) No holes or free electrons
d) Many free electrons

Q.1 B) Fill in the blanks OR write True /False   **06**
1) if σ is the conductivity, the relation between the electric field E and the current density J in a conducting medium is _____.
2) Liquid-phase epitaxy (LPE) uses _____ to grow crystals on a substrate.
3) In Czochralski crystal growth process, the material is heated up to _____.
4) In a semiconductor, the energy gap between the valence band and conduction band is about 1eV. (True/False)
5) Electron-hole pairs are produced by Thermal energy. (True/False)
6) Ohm's law is not obeyed by Insulator. (True/False)

Q.2 Answer the following.   **16**
a) Optical absorption
b) Effective mass of an electron
c) Hydrothermal process
d) Fermi level pinning

Q.3 a) Describes variation of energy bands with alloy composition with suitable example.   **10**
b) Elucidate effective mass of an electron.   **06**

Q.4 a) What is Luminescence? Describe different type of Luminescence with example.   **10**
b) A 0.5 μm thick sample of Indium (In) is illuminated with monochromatic light of $h\upsilon$=1.5eV. The absorption coefficient 10^4cm^{-1}. The power incident on the sample in 15mW. Find the total energy absorbed by the sample per second (J/sec).   **06**

Q.5 a) Explain MS structure with band diagram. Explain current flow mechanism in MS junction.   **10**
b) Show the equilibrium energy band diagram for a metal to an p-type semiconductor where   **06**
1) $\Phi M < \Phi S$ and
2) $\Phi M > \Phi S$

Q.6 a) Describe crystal growth by Czochralski method.   **10**
b) Explain Chemical vapor deposit with suitable example.   **06**

Q.7 a) Describe crystal growth by Molecular Beam Epitaxy.   **10**
b) Explain vapor phase epitaxy.   **06**

Seat No.	

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Atomic and Molecular Physics (MSC10302)

Day & Date: Tuesday, 11-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
                2) Attempt any three questions from Q. No. 3 to Q. No. 7
                3) Figure to right indicate full marks.

Q.1 A) Choose correct alternative. (MCQ)   10

1) In the $L-S$ coupling scheme, the terms arising from two non-equivalent $p-$electrons are _____.
   a) $^3S, {}^1P, {}^3P, {}^1D, {}^3D$ b) $^1S, {}^3S, {}^1P, {}^1D$
   c) $^1S, {}^3S, {}^3P, {}^3D$ d) $^1S, {}^3S, {}^1P, {}^3P, {}^1D, {}^3D$

2) The spectral term separation ΔT is expressed in terms of cm^{-1} which is caused due to spin-orbit interaction is related to the atomic number Z by _____
   a) Z^4 b) Z^3
   c) Z^{-4} d) Z^{-1}

3) The total number of 'd' electrons in Fe^{2+} (Atomic No. of Fe is 26) is NOT equal to that of the total number of _____.
   a) $p-$ electrons in Ne (Atomic No. 10)
   b) $d-$ electrons in Fe atom
   c) $p-$ electrons in Cl$^-$ ion (Atomic no. of Cl is 17)
   d) $s-$ electrons of Mg (Atomic no. of Mg is 12)

4) The outer electronic configuration of Mn^{2+} is $3d^5 4s^0$. By employing the Hund's rules of $L-S$ coupling the ground state of Mn^{2+} is characterized by the spectroscopic term _____.
   a) $^6S_{5/2}$ b) $^2D_{5/2}$
   c) $^2F_{5/2}$ d) $^6H_{5/2}$

5) At 0 K, the vibrational energy of a molecule is_____
   a) 0   b) $\hbar\omega$
   c) $\hbar\omega/2$ d) $\hbar\omega/3$

6) The bond order for the O$_2$ molecule is _____.
   a) 1   b) 2
   c) 2.5   d) 0

7) The transition of longer wavelength observed in the case of Orthohelium is _____.
   a) $2^3P_{0,1,2} \longrightarrow 2^3S_1$ b) $2^1P_1 \longrightarrow 2^1S_0$
   c) $3^3P_{0,1,2} \longrightarrow 2^3S_1$ d) $3^1P_1 \longrightarrow 1^1S_0$

8) The total number of emission lines observed during the transition of electrons from $3^2P_{3/2}$ to $3^2S_{3/2}$ are _____
   a) 2   b) 4
   c) 6   d) 8

9) The spectroscopic symbol for the ground state of $A1$ $(Z = 13)$ is $^2P_{1/2}$ Under the action of a strong magnetic field (when L-S coupling can be neglected) the ground state energy level will split into _____.
   a) 3 levels   b) 4 levels
   c) 5 levels   d) 6 levels

10) The fine structure of atomic spectral lines arises from _____.
   a) Electron spin-orbit coupling
   b) Interaction between electron and nucleus
   c) Nuclear spin
   d) Stark effect

B) Fill in the blanks or Write true /false.   **06**
   1) According to Moseley's law, the frequency of a spectral line in an X-ray spectrum varies as a square of the atomic number of the element.
      - (True/False)
   2) The shortest wavelength observed in the Paschen series of hydrogen spectra is 8201 Å.
   3) The spectral term separation ΔT is expressed in terms of cm^{-1} which is caused due to spin orbit interaction and is related to the atomic number Z by Z^{-4}. – (True/False)
   4) The Lande's g-factor for $^7G_1$ is ½. – (True/False)
   5) There are 9 bands observed in the IR spectrum of water due to fundamental vibrations. – (True/ False)
   6) The Raman shift is expressed in cm^{-1}. – (True/False)

Q.2 Answer the following questions.   **16**
   a) Deduce the ground state term symbol for sodium $(Z = 11)$. Why sodium exhibit doublets of yellow color. With neat labelled diagram explain the Zeeman effect for sodium atom when it is placed in weak magnetic field.
   b) Using Hund's rules, find the ground-state term symbol for
      1) fluorine $(Z = 9)$
      2) titanium $(Z = 22)$
      3) Nickel $(Z = 28)$
      4) magnesium $(Z=12)$
   c) What is Stark effect? discuss the weak-field Stark effect in hydrogen for Hα line.
   d) From the following data, find the energy required to dissociate a KCI molecule into a K atom and a Cl atom. The first ionization potential of K is 4.34 eV; the electron affinity of Cl is 3.82 eV; the equilibrium separation of KC1 is 2.79 Å. (Hint: Show that the mutual potential energy of K$^+$ and Cl$^-$ is — (14.40/R) eV if R is given in Angstroms).
   $$\left(\frac{e^2}{4\pi\varepsilon_0} = 1.44 \times 10^{-9}eV.m\right)$$

Q.3 Answer the following
   a) 1) Discuss the basic foundation behind the magnetic spin resonance   **08**
         spectroscopy Techniques?
      2) Differentiate between nuclear magnetic resonance and electron paramagnetic resonance spectroscopic techniques.
      3) Show how many signals you will see in the electron spin resonance spectrum of H-atom considering nuclear hyperfine interaction. Sketch the predicted spectrum in first derivative form and label it properly.
      4) If the observed chemical shift of a proton is 200 Hz from tetramethyl silane $(CH_3)_4Si$ and instrument frequency is 60 MHz, what is the chemical shift in terms of δ? Express it in τ value.

b) 1) Explain Raman effect and origin of Raman spectroscopy with the help **08**
of energy level diagram. Why anti-Stokes lines are less intense than
Stokes line.

2) In a linear molecule the Raman shift of the first Stokes/anti-Stokes
line from the exciting one is 6B cm^{-1} whereas separation between
adjacent lines is 4B cm^{-1}. why?

3) With which type of spectroscopy would one observe the pure
rotational spectrum of H_2? If the bond length of H_2 is 0.07417 nm,
what would be the spacing of the first three lines in the spectrum?

Q.4 Answer the following

a) 1) In a multielectron atom, consider two identical particles (electrons, **08**
noninteracting). Let ψ_α and ψ_β be the eigenfunctions corresponding to
the states α and β, in which the two particles can be found.
Considering total eigenfunctions, show that the two particles can not
be in a state with the same set of quantum numbers.

2) Evaluate the Lange' g factor for the $^3P_1$ state in $2p3s$ configuration of
^6C. On the application of a magnetic field $B = 0.1$ tesla, calculate the
Zeeman splitting of the state ΔE in joules. ($\mu_b = 9.2740 \times 10^{-24} J / T$)

3) Nitrogen ($Z = 7$) has three electrons in the $2p$ level (in addition to two
electrons each in the $1s$ and $2s$ levels),
   i)   Consistent with the Pauli principle, what is the maximum possible
value of the total Ms of all seven electrons?
   ii) List the quantum numbers of the three $2p$ electrons that result in the
largest total Ms.
   iii) If the electrons in the $2p$ level occupy states that maximize Ms,
what would be the maximum possible value for the total M_L?
   iv) What would be the maximum possible total M_L if the three $2p$
electrons were in states that did not maximize Ms?

b) Distinguish conceptually between the splitting of fine structured spectral **08**
lines under the action of external weak (< 0.1 T) and high (> 1 T) magnetic
field strength. An atom with the states $^2G_{9/2}$ and $^2H_{11/2}$ is placed in a weak
(< 0.1 T) magnetic field. Draw the energy levels and indicate the possible
allowed transitions between the two states with π and σ components.

Q.5 Answer the following.

a) 1) Discuss the vibrational-rotational spectra of a diatomic molecule by **08**
showing P, Q and R branches with proper selection rules,

2) Designate proper branches (P, Q and R) for the following type of
vibrations of a heteronuclear diatomic molecule
   i)   Symmetric stretching mode in which dipole vibrate parallelly
along the bond length.
   ii) Bending mode in which dipole vibrate perpendicularly along the
bond length,

3) Explain why vibrational-rotational spectra cannot be obtained for
homonuclear diatomic molecules having identical nuclei?

b) Certain atom with two valence electrons is subjected to very strong **08**
magnetic field strength of the order of > 10 T. Draw the energy levels and
indicate the possible allowed transitions between $^3S_1 \leftarrow {}^3P_{0,1,2}$ transitions in
that atom. Justify the phenomenon of Paschen-Back effect by considering
magnetic interaction energy i.e. ΔE as well as selection rules.

Q.6 **Answer the following.**

a) Write down the allowed spectral terms for Germanium (Z = 32) and Oxygen   **08**
(Z= 8) atoms in their normal and first excited state and by applying selection
rules explain the emission spectra of Germanium (Z = 32) and Oxygen
(Z= 8) (Consider Pauli's Exclusion Principle).

b) Find the most probable radius for the electron of a hydrogen (Z =1) atom in   **08**
the $1s$ states. Given, $P_{1,0}(r) = \frac{4r^2}{a_0^3} e^{\frac{-2r}{a_0}}$. Calculate the average orbital radius
of a $1s$ electron in the hydrogen atom. What is the probability of the electron
in the $1s$ state of the hydrogen atom being at a radius greater than the Bohr
radius a_0? (Given, e =2.71818)

Given: $\int_0^\infty x^m . e^{-ax^n} dx = \frac{1}{n} \frac{\Gamma(\frac{m+1}{n})}{a^{(m+1)/n}}$; $\Gamma(n) = (n-1)!$

Q.7 **Answer the following.**

a) Based on molecular orbital (MO) concept explain the nature of bond order   **08**
and stability for O_2, O_2^+, O_2^- and O_2^{--} molecules. Also, explain the magnetic
nature of each molecule. Why valence bond (VB) approach fails to explain
the paramagnetic nature for O_2 and B_2 molecules, while molecular orbital
approach explains the paramagnetic nature for O_2 and B_2 molecules.

b) 1) What are non-equivalent and equivalent electrons? Is it possible to   **08**
have two equivalent electrons in the same atom? Calculate the
spectral terms for non-equivalent (s,s) (s,p) and (p,p) electrons and
for two equivalent (s^2) and (p^2) electrons.

2) What do you mean fine structure? With neat labelled diagram
discuss the fine structure of doublets for
i) $^2P_{1/2}$ and $^2P_{3/2}$ and
ii) $^2D_{3/2}$ and $^2D_{5/2}$ states with justification based on magnitude
of ΔT_{ls}.

3) Calculate the ESR frequency of an unpaired electron in a magnetic
field of 3000 G (0.30 T).
$(g = 2.00, \mu_B = 9.273 \times 10^{-24} \ J/T, \ h = 6.626 \times 10^{-34} Js)$

Seat No.

M.Sc. (Semester - III) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Experimental Techniques for Physics (MSC10307)

Day & Date: Wednesday, 12-07-2023   Max. Marks: 80
Time: 11:00 AM To 02:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
      2) Attempt any three questions from Q. No. 3 to Q. No. 7
      3) Figure to right indicate full marks.

Q.1 **A)** **Fill in the blanks by choosing correct alternatives given below.**   **10**

1) when a molecule absorbs infrared radiation then molecule _____.
   a) warms up   b) flies around
   c) vibrates faster   d) emits light

2) X-rays are generated by _____.
   a) Geiger tube   b) Goniometer
   c) Coolidge tube   d) Rotameter

3) Raman lines are _____.
   a) Weak   b) Strong
   c) Curved   d) Blurry

4) For a particular vibrational mode to appear in the Raman spectrum, _____ must change.
   a) Frequency of radiation   b) Intensity of radiation
   c) Molecule's shape   d) Molecule's polarizability

5) The shielding effectiveness can be calculated as _____.
   a) $S = A + C + B$ b) $S = A + R + B$
   c) $S = D + R + B$ d) None of these

6) The Thermogravimetric analysis measures the change in _____ with temperature.
   a) Mass   b) Enthalpy
   c) thermal conductivity   d) Entropy

7) In X-ray Photoelectron Spectroscopy (XPS) _____.
   a) Impinged x-ray radiation will remove peripheral electron.
   b) Impinged x-ray radiation does not remove any of the electron.
   c) Impinged x-ray radiation does not interact with the material at all
   d) Impinged X-ray radiation will remove the core shell electron

8) All weather meters that measure relative humidity are also known as _____.
   a) Transducer   b) Sensor
   c) Hygrometers   d) All of these

9) LCR meters can be used measure _____.
   a) Resistance   b) Inductance
   c) Capacitance   d) All of these

10) The CMRR of an in-amp will be around _____.
   a) 50dB   b) 100dB
   c) 120dB   d) 200dB

B) Fill in the blanks OR Write true/ false. **06**
   1) As the applied voltage increases, the minimum wavelength of X-radiation from a metal increases.
   2) Ruby laser works on the principle of a four level system.
   3) The secondary electrons generated in SEM are useful for morphology and topography.
   4) Liquid used in LCD's are nematic.
   5) Four probe method is used to measure thermal conductivity of semiconductor.
   6) Dew point hygrometer device is used for measuring the saturation of moisture in gas.

Q.2 Answer the following **16**
   a) What is temporal coherence?
   b) Write the advantages of four probe method over two probe method.
   c) What is sensor? Discuss classification of sensors.
   d) Explain the working of Hygrometer.

Q.3 Answer the following **16**
   a) Explain in details construction and working of tunnelling electron microscopy.
   b) What is Grounding? Discuss types of grounding in electronic instrumentation.

Q.4 Answer the following **16**
   a) Explain the working oil diffusion pump.
   b) Explain the working of linear variable differential transformer LVDT.

Q.5 Answer the following **16**
   a) Discuss in details the theory, working and applications of Differential Scanning Calorimetery (DSC).
   b) Explain the methods to obtain low temperature.

Q.6 Answer the following **16**
   a) Explain the working of X-ray diffraction method for the analysis of crystal structure.
   b) Explain the working of atomic force microscope (AFM) with suitable diagram.

Q.7 Answer the following **16**
   a) Explain the working of Helium-Neonlaser with suitable diagram.
   b) Explain the working principle of UV-Visible spectroscopy.

Seat No.		Set	P

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Semiconductor Devices(MSC10401)

Day & Date: Monday, 10-07-2023   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question Nos.1 and 2 are compulsory.
         2) Attempt any three questions from Q. No. 3 to Q. No. 7.
         3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternatives from the options.   **10**

1) CMOS is popular due to _____.
   a) Low noise immunity
   b) High power consumption
   c) Low power consumption
   d) High power dissipation

2) _____ devices are not a unipolar device
   a) DE-MOSFET   b) MOSFET
   c) JFET   d) BJT

3) The condition $h\upsilon > E_g$ causes _____ of light semiconductor.
   a) Absorption   b) Transmission
   c) Reflection   d) Modulation

4) A negative gate voltage to n - channel MOSFET causes _____ of carriers.
   a) Depletion   b) Enhancement
   c) Saturation   d) Induction

5) A potential well is created in p - semiconductor by applying _____ in CCD memory device to store charge.
   a) positive potential   b) negative potential
   b) square negative pulse   d) sinusoidal pulse

6) The output of LASER is _____.
   a) Polychromatic   b) non – coherent
   c) Dispersed   d) Monochromatic

7) Energy required to move electron from Fermi level to outside the metal is called as _____.
   a) Barrier   b) work function
   c) Depletion   d) dielectric constant

8) The switching ON behavior of SCR is based on _____.
   a) Regenerative   b) Breakdown
   c) Blocking   d) Etching

9) Anode voltage must be _____ V, if gate voltage is 0.3 V to switch on programmable unijunction transistor.
    a) 1.0   b) 0.3
    c) 0.8   d) 0.5

10) Sum of α_1 and α_2 must be _____ for SCR to become ON.
    a) zero   b) unity
    c) half   d) infinity

B) State True or False/Fill gaps.   **06**
    1) VLSI use CCDs for memory.
    2) Forward blocking state in SCR is due to forward biased J1 junction.
    3) Minimum current above which SCR becomes ON is holding.
    4) Light emission is not possible in Si due to its _____
    5) The barrier height of M – S contact is the difference between metal work function of semiconductor _____.
    6) The drift of stable domains in TEDs is attainable in _____ loaded circuits.

Q.2 Answer the following.   **16**
    a) LED
    b) CMOS devices
    c) Digital IC
    d) DIACs

Q.3 a) Describe MOS structure with emphasis on accumulation, depletion & inversion modes with band diagrams.   **10**
    b) Elucidate Depletion type MOSFET.   **06**

Q.4 a) Describe p-i-n diode with doping profile and electric field distribution. **10**
    b) LASCR   **06**

Q.5 a) Explain GaAs Gun Oscillator modes with,   **10**
    i)   space charge accumulation
    ii)   Quenched domain mode
    iii) Delayed domain mode.
    b) Explain the periodic oscillating behavior of n- GaAs Gunn diode. **06**

Q.6 a) Describe the operating principle of photodiode based on multilayer hetrojunction with band diagrams and IV characteristics.   **10**
    b) What is Semiconductor Laser diode? Discuss the mechanism of stimulated emission of light in GaAs laser diode.   **06**

Q.7 a) What is solar cell? Derive an expression for open circuit voltage and short circuit current.   **10**
    b) Explain quantum efficiency and response speed of solar cell. **06**

Seat No.	

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS(SOLID STATE PHYSICS)
Nuclear and Particle Physics (MSC10402)

Day & Date: Wednesday, 12-07-2023   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Q. Nos. 1 and. 2 are compulsory.
             2) Attempt any three questions from Q. No. 3 to Q. No. 7
             3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternative.   **10**

1) The ratio will be _____, Where, R is the mean nuclear radius.
   a) 0.8   b) 0.4
   c) 1.25   d) 8

2) Nuclear forces between the nucleons are _____.
   a) Central force   b) Non-central forces
   c) Purely Coulombic forces   d) Cohesive forces

3) What is the correct sequence of shell closure according to extreme single particle shell model?
   a) 2, 6, 10, 14, 18, 32
   b) 2, 8, 18, 32, 50, 86
   c) 2, 8, 20, 50, 82, 126
   d) 2, 8, 20, 40, 82, 126

4) In a typical nomenclature of nuclear reaction, _____.
   a) is parent, is incident photon, is daughter and n being outgoing particle
   b) is parent, n is incident particle, is daughter and photon is out-going
   c) is daughter, n is incident particle, is parent and photon is out-going
   d) is parent, is daughter, n and both are out-going particles

5) All the nucleii's available in nature are _____.
   a) Spherical shape and are symmetric
   b) Some are spherical, some ellipsoid shape
   c) All are ellipsoid shape
   d) No definite shape

6) Nucleons in the nucleus of an atom are _____.
   a) Uniformly distributed up to a certain distance and then falls off sharply at the boundary
   b) They are dense at the center and then distribution falls sharply at the boundary
   c) Distribution is even and uniform at the centre as well as at the boundary
   d) Distribution is uneven everywhere

7) The height of potential barrier faced by an alpha-particle inside the nucleus is _____.
   a) 27.87 MeV   b) 27.87 KeV
   c) 27.87 GeV   d) 27.87 eV

8) Simplest two nucleon system exists in nature is of _____
   a) p-p
   b) n-p
   c) n-n
   d) Does not exist

9) Beta particle is stopped in an ionization chamber producing ion-pairs. Average energy required to produce an ion pair is 35 eV. What is the kinetic energy of beta-particles entering the ionisation chamber.
   a) 35 MeV
   b) 3.5 MeV
   c) 3.5 GeV
   d) 35 GeV

10) The average binding energy per nucleon of nucleus is _____.
    [Given: neutron mass m_n= 1.008665 u, proton mass m_p=1.007825 u, where 1 u = 931.5 MeV/c^2]
    a) 5.60 MeV
    b) 21.4 MeV
    c) 8.5 MeV
    d) 36 MeV

B) Fill in the blanks OR Write true/ false.   **06**
1) Nuclear density is constant for all nuclei.
2) Nucleon-nucleon forces are spin dependent forces.
3) Leptons are the only elementary particles that experiences all four fundamental forces of nature.
4) Baryons consist of three quark and Mesons consist of one quark and anti-quark.
5) Electron capture is one of the modes of beta decay process.
6) In radioactivity, after one half-life, activity of a radioactive substance reduces to half.

Q.2 Answer the following   **16**
a) A sample of an ancient wooden sculpture piece gives 5 count/min/g of carbon due to ^{14}C present in it. If freshly cut wooden piece gives 16 counts/min, what is the age of sculpture? [Given Half-life of ^{14}C=5760 years]
b) Explain the working and basic principle of semiconductor detector. Draw neat schematic figure to mention each component of the counter.
c) Explain the gamma decay, internal conversion and internal pair conversion of gamma decay process.
d) Draw the Meson octate, identify the particles in it along with their quark structures, charges and spins.

Q.3 Answer the following
a) Calculate the value of proton separation energy (S_p) for (S_n) for in units of MeV.   **08**
   [Given M() =20.007344 u, M() =20.997651 u, M() =21.999574 u, neutron mass m_n =1.008665 u, proton mass m_p= 1.007825 u, where 1 u = 931.5 MeV/c^2]
b) Using semi-empirical mass formula, for given family of isobars, obtain the relation for most stable nuclei.   **08**
   [constants in semi-empirical formula: Volume term, Surface term, Coulomb term, asymmetry term, pairing term]

Q.4 Answer the following
a) Using Fermi gas model and its basic assumptions, estimate the potential depth for a nucleus. Assuming average binding energy per nucleon to be around 8.5 MeV, calculate the kinetic energy of the nucleons in the nucleus.   **08**
b) Find the Q-value and the threshold for the following nuclear reaction.   **08**
   [Given M() =22.99097 u, M()= 19.999981 u, M() = 4.002603 u, neutron mass m_n =1.008665 u, proton mass m_p= 1.007825 u, where 1 u = 931.5 MeV/c^2]

Q.5   Answer the following

a)   Write down the Schrodinger equation for deuteron (use simplest finite   **08**
square well potential), i.e. n-p system with an attractive potential $V(r)$
between them. Obtain the complete solution and draw the wavefunction
inside and outside the potential well.

b)   From Gamma ray selection rule classify the following multipole transitions.   **08**
    i) $(1/2)^- \to (7/2)^-$
    ii) $4^+ \to 2^+$
    iii) $1^- \to 2^+$
    iv) $(1/2)^- \to 3/2^+$

Q.6   Answer the following

a)   Starting with the equation of Fermi-Golden's rule, derive the Fermi   **10**
expression of beta-decay.

b)   Show that the energy of the triplet state (S=1) is not equal to the energy of   **06**
the singlet state (S=0) for deuteron bound state.

Q.7   Answer the following

a)   Classify different types of accelerators. Explain basic principle and describe   **10**
in detail working of linear accelerator. Draw a neat schematic diagram to
show each component.

b)   With a suitable example explain what is nuclear fission and fusion reactions.   **06**
Estimate the power released in Kilo-Watt-Day for the thermal neutron
induced fission reaction of to and.
[Given M() =235.043922 u, M()=146.922780 u, M() = 88.926400 u. neutron
mass m_n= 1.008665 u, proton mass m_p= 1.007825 u, m_e= 0.00055 u where
1 u = 931.5 MeV/c^2]

Seat No.

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Thin Film Physics and Technology (MSC10403)

Day & Date: Friday, 14-07-2023　　　　　　　　　　　　　　　Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
　　　　　　　　2) Attempt any three questions from Q. No. 3 to Q. No. 7.
　　　　　　　　3) Figure to right indicate full marks.

Q.1　A)　Chose correct alternative. 　　　　　　　　　　　　　　　**10**

1) Chemical vapor deposition is a method used to obtain which of the following substance?
   a) Semiconductor 　　　　　　b) Non conducting polymers
   c) Crystalline semiconductor 　d) Conducting compound

2) Which technology is used to get cheap resistor and capacitor?
   a) Thin film 　　　　　　　　b) Thin and Thick film
   c) Thick film 　　　　　　　　d) none of the mentioned

3) _____ can be doped with P or B to reduce resistivity.
   a) Silicon dioxide 　　　　　　b) Silicon nitride
   c) Silicon oxy nitride 　　　　d) Polysilicon

4) _____ metal is not used in metallization.
   a) Aluminium 　　　　　　　　b) Chromium
   c) Sodium 　　　　　　　　　d) Nickel

5) To ensure the formation of condensation nuclei, the evaporation rate must be sufficiently_____.
   a) low 　　　　　　　　　　b) high
   c) no any relation 　　　　　d) low as well as high

6) PECVD is used for the deposition of _____ thin film.
   a) metal 　　　　　　　　　b) dielectric
   c) plasma 　　　　　　　　　d) conducting

7) Spray pyrolysis is an example of_____ phase synthesis.
   a) solid 　　　　　　　　　　b) liquid
   c) gas 　　　　　　　　　　d) plasma

8) In RF sputtering, the frequency of is used for RF power supply equipment.
   a) 13.56 Hz 　　　　　　　　b) 13.56 K Hz
   c) 13.56 MHz 　　　　　　　d) 13.56 GHz

9) Electrodeposition is a _____ phase chemical method of synthesis of nanostructured material.
   a) solid 　　　　　　　　　　b) liquid
   c) gas 　　　　　　　　　　d) plasma

10) Magnetron sputtering deposition process in which the _____ voltage is delivered across a_____ pressure gas to create high energy plasma.
   a) high, high   b) high, low
   c) low, low   d) low, high

B) State true or false.   **06**
   1) LASER evaporation is the process by which the source material is evaporated by using focused _____beam.
   2) Spray pyrolysis is chemical deposition technique. True / False
   3) Energies of the order of_____ correspond to physical adsorption.
   4) Thin film growth in which small nuclei are formed over the surface of substrate is called nucleation. True / False
   5) Polysilicon serves as oxide layer material in MOS devices. True / False
   6) In thin film transistor, glass substrate supports a semiconducting film usually of Cds or CdSe. True / False

Q.2 Answer the following.   **16**
   a) Write a note on Miller indices.
   b) Explain dielectric deposition.
   c) Write a note on laser ablation.
   d) Explain principle of sputtering.

Q.3 Answer the following.
   a) Explain how synthesis of nano materials is carried out by the process of spray pyro lysis? What are its advantages and drawbacks?   **10**
   b) Explain polysilicon deposition.   **06**

Q.4 Answer the following.
   a) Discuss briefly about electrodeposition technique of deposition of thin films with its mechanism.   **10**
   b) Write a note on Metallization.   **06**

Q.5 Answer the following.
   a) What do you understand by precursors in a CVD process? Write various types of precursors materials used in CVD process.   **08**
   b) With neat diagram, explain formation stages of thin film.   **08**

Q.6 Answer the following.
   a) Describe magnetron sputtering method for the deposition of thin film. What are its advantages?   **10**
   b) Explain dielectric properties of thin film.   **06**

Q.7 Answer the following.
   a) Describe laser evaporation method for depositing thin film. What are its advantages?   **10**
   b) Discuss conduction properties in metal thin film.   **06**

Seat No.			**Set**	**P**

M.Sc. (Semester - IV) (New) (CBCS) Examination: March/April-2023
PHYSICS (SOLID STATE PHYSICS)
Material Characterization Techniques (MSC10406)

Day & Date: Sunday, 16-07-2023   Max. Marks: 80
Time: 03:00 PM To 06:00 PM

Instructions: 1) Question no. 1 and 2 are compulsory.
2) Attempt any three questions from Q. No. 3 to Q. No. 7.
3) Figure to right indicate full marks.

Q.1 A) Choose the correct alternatives.   **10**

1) Oil immersion objective lens has an NA value of_____.
   a) 0.65   b) 0.85
   c) 1.33   d) 1.00

2) In fluorescence microscopy, which of the following performs the function of removing all light except the blue light?
   a) Exciter filter   b) Barrier filter
   c) Dichroic mirror   d) Mercury arc lamp

3) Zeeman interaction corresponds to the interaction of a nuclear moment with magnetic field of the order of_____.
   a) 2-10 tesla   b) 1-10 tesla
   b) 1-20 tesla   d) 1-100 tesla

4) The resolving power of TEM is derived from_____.
   a) Electrons   b) specimens
   c) Power   d) ocular system

5) The AFM uses a_____ to scan the surface of a molecule.
   a) X-ray film   b) Nanosized tip
   c) Non-metal tip   d) Nanodrop

6) Which of the following is an Auger transition starting from a hole in Is levels which would be filled up from the 2p level?
   a) KLM transition   b) KLL transition
   c) LMN transition   d) LLM transition

7) What causes the splitting of energy levels in a magnetic field?
   a) Hund's Rule   b) Zeeman Effect
   c) van der Waals interactions   d) Aufbau Principle

8) Total Magnification is obtained by_____.
   a) Magnifying power of the objective lens
   b) Magnifying power of eyepiece
   c) Magnifying power of condenser lens
   d) Magnifying power of both the objective lens and eyepiece

9) Which of the following is the detection limit of Auger Electron Spectroscopy?
   a) 0.1% monolayer   b) 0.5% monolayer
   c) 1% monolayer   d) 2% monolayer

10) The relaxation time along the direction of static magnetic field B_0 is_____.
   a) Longitudinal relaxation time T_1
   b) Longitudinal relaxation time T_2
   c) Transverse relaxation time T_1
   d) Transverse relaxation time T_2

B) Write true or false.   06
   1) EPR spectroscopy infrared wavelength of the radiation is not used.
   2) Wavelength of light is a function of Resolving power of a microscope.
   3) Discrete electrons can be observed in electron ionization of an atom in electron-electron interaction.
   4) Negative Staining is examining for virus particles, protein molecules and bacterial flagella.
   5) The Nuclear spin Hamiltonian is separated into two important groups.
   6) Vacuum is needed inside the X-Ray Photoelectron spectrometer.

Q.2 Answer the following.   16
   a) Write a note on difference between SEM and TEM.
   b) Discuss advantages and disadvantages of Scanning Tunneling Microscope.
   c) Write a note on Resolution and Magnification.
   d) Explain elastic and inelastic scattering.

Q.3 Answer the following.   16
   a) Explain principle, instrumentation and working of AFM (Atomic force Microscope).
   b) Draw the schematic diagram of AES and explain the working of each part of the microscope?

Q.4 Answer the following.   16
   a) Explain Phase Contrast microscopy in detail.
   b) Explain Magic Angle Spinning (MAS).

Q.5 Answer the following.   16
   a) Explain Principle of Diffraction of light in detail.
   b) Write a note on contact and non-contact modes in Atomic Force Microscope (AFM).

Q.6 Answer the following.   16
   a) Draw schematic of SEM and explain working of each part.
   b) Explain Raman Spectroscopy with the help of classical and quantum approach.

Q.7 Answer the following.   16
   a) Discuss Differential Interference Contrast (DIC) microscopy in detail.
   b) Explain principle and working of NMR Spectroscopy and write its applications.