

Seat
No.

Set P

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Mathematical Physics (2307101)

Day & Date: Friday, 05-01-2024
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

Instructions: 1) All questions are compulsory.
 2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative.**08**

- 1) The value of $\int_{-\pi}^{\pi} \cos(mx) \sin(nx) dx = \underline{\hspace{2cm}}$.
 a) 1
 b) $a - 1$
 c) 0
 d) π
- 2) If $|z^2 - 1| = |z^2| + 1$ then z lies on _____.
 a) the real axis
 b) the imaginary axis
 c) a circle
 d) on ellipse
- 3) 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
- 4) Find the pole of $f(z) = \sin \frac{1}{(z-a)}$ = _____.
 a) $z = a$
 b) $z = 0$
 c) $z = 1$
 d) $z = 4$
- 5) 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
- 6) Legendre polynomial is a set of _____ function.
 a) orthogonal
 b) odd
 c) even
 d) real
- 7) If $f(z) = e^{2z}$ then the imaginary part of $f(z)$ is _____.
 a) $e^y \sin x$
 b) $e^x \cos y$
 c) $e^{2x} \cos 2y$
 d) $e^{2x} \sin 2y$
- 8) What are the eigen values 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

B) Fill in the blanks OR write true/false.**04**

- 1) Fourier transform is a linear operator. (True/ False)
- 2) Inverse of unitary matrix is unitary matrix. (True/ False)
- 3) A square matrix is called orthogonal if $A = A^{-1}$. (True/ False)
- 4) $x \frac{\partial u}{\partial x} + t \frac{\partial u}{\partial t} = 2u$ is on ordinary differential equation. (True/ False)

Q.2 Answer the following. (Any Six)

- a) Find the pole $f(z) = \sin\left(\frac{1}{z-a}\right)$
- b) What are the conditions for a matrix to be orthogonal matrix?
- c) Solve $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} = 9y = 0$
- d) Find the Laplace transform of the function

$$f(t) = te^{-t} \sin 2t$$
- e) Find the pole of $f(z) = \frac{\sin(z-a)}{(z-a)^4}$
- f) Show that inverse of an orthogonal matrix is orthogonal.
- g) Solve $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} + 6y = 0$
- h) Define singular point, explain in details its types with example.

Q.3 Answer the following. (Any Three)

12

- a) Discuss in details Cauchy's Integral Formula.
- b) State and prove the Parseval's Theorem.
- c) Show that the eigen value of Hermitian matrix are real.
- d) Find the Fourier Transform of e^{-ax^2} where $a > 0$

Q.4 Answer the following. (Any Two)

12

- a) Write matrix A gives below as the sum of symmetric & a skew symmetric matrix.

$$A = \begin{pmatrix} 1 & 2 & 4 \\ -2 & 5 & 3 \\ -1 & 6 & 3 \end{pmatrix}$$

- b) In square wave expand the function
 $f(x) = 0; -\pi \leq x \leq 0$
 $f(x) = h; 0 \leq x \leq \pi$ fourier
- c) Evaluate the following integral using residue Theorem.
 $\int_c \frac{1+z}{z(2-z)} dz$ where c is circle $|z| = 1$

Q.5 Answer the following. (Any Two)

12

- a) Evaluate $\int_0^\infty \frac{\cos 3\theta}{5+4\cos\theta} d\theta$
- b) Solve; $x \frac{dy}{dx} + y \log y = xy e^x$
- c) Solve the differential equation.
 $y \log y dx + (x - \log y) dy = 0$

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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Solid State Physics (2307102)

Day & Date: Sunday, 07-01-2024
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

Instructions: 1) All questions are compulsory.
 2) The figure to right indicate full marks.

Q.1 A) Choose the correct alternative. 08

- 1) Conductivity of metals depends upon _____.
 - a) The nature of the material
 - b) Number of free electrons
 - c) Resistance of the metal
 - d) Number of electrons
- 2) At what temperature does ferromagnetic material become paramagnetic?
 - a) Melting
 - b) Curie
 - c) Neel
 - d) None of these
- 3) Which of the following is a strong magnet?
 - a) Diamagnetic material
 - b) Paramagnetic material
 - c) Antiferromagnetic material
 - d) Ferromagnetic material
- 4) Electronic polarization also known as _____.
 - a) molecular polarization
 - b) magnetic polarization
 - c) atomic polarization
 - d) orientation polarization
- 5) What is the phenomenon where a material exhibits zero electrical resistance below a certain critical temperature?
 - a) Superconductivity
 - b) Conductivity
 - c) Resistance
 - d) Insulation
- 6) For which of the following is magnetic susceptibility negative?
 - a) Paramagnetic Materials only
 - b) Ferromagnetic Materials only
 - c) Diamagnetic Materials
 - d) none of the above
- 7) The sprinkling of water reduces slightly the temperature of a closed room because
 - a) Water is a bad conductor of heat
 - b) Water has a large latent heat of vaporization
 - c) The temperature of the water is less than the room
 - d) None of the above
- 8) Which of the following is a property of a superconductor?
 - a) Perfect diamagnetism
 - b) High electrical resistance
 - c) Low electrical conductivity
 - d) Non-zero resistivity

- B) Fill in the blanks OR write true / false. 04**
- 1) The SI unit of magnetic field intensity is _____.
 - 2) The magnetization 'M' of a superconductor in a field is _____.
 - 3) When a paramagnetic material is heated above Curie temperature it becomes non-magnetic.
 - 4) The temperature above which an antiferromagnetic material becomes paramagnetic is called the melting temperature.
- Q.2 Answer the following. (Any Six). 12**
- a) What is Curie Temperature?
 - b) Define diamagnetic materials.
 - c) Define specific heat.
 - d) What is orientational polarization?
 - e) What is an extrinsic semiconductor?
 - f) What is penetration depth?
 - g) State the concept of ferroelectricity.
 - h) Define Neel temperature.
- Q.3 Answer the following (Any Three) 12**
- a) Explain in Brillouin zones in 2-D.
 - b) Write about the direct and indirect band gap of semiconductors.
 - c) Explain Meissner's effect.
 - d) Write a note on the conductivity of solids.
- Q.4 Answer the following (Any Two) 12**
- a) Electronic polarization
 - b) Explain the Kronig-Penny model.
 - c) Explain the thermodynamics of superconductors.
- Q.5 Answer the following (Any Two) 12**
- a) Write the difference between metal, semiconductors and insulators.
 - b) Write a note on Josephson's tunnelling and its theory.
 - c) Explain the Clausius-Mossotti equation

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**M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Analog and Digital Electronics (2307106)**

Day & Date: Tuesday, 09-01-2024
Time: 03:00 PM To 05:30 PM

Max. Marks: 60

Instructions: 1) All Questions are compulsory.
2) Figure to right indicate full marks.

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

08

- 1) The feedback path in an op-amp integrator consists of _____.
 - a) A resistor
 - b) A capacitor
 - c) A resistor and capacitor in series
 - d) A resistor and capacitor in parallel
- 2) Multiplexer has _____.
 - a) Many input and one output
 - b) One input many output
 - c) Many input and many out put
 - d) One input and one output
- 3) Op- amp is a _____ type of amplifier.

a) Current	b) Voltage
c) Power	d) Resistance
- 4) The op-amp comparator circuit uses _____.

a) Positive feedback	b) Negative feedback
c) Regenerative feedback	d) No feedback
- 5) Find the output of inverting amplifier?

a) $V_o = AV_{in}$	b) $V_o = -AV_{in}$
c) $V_o = -A(V_{in1}-V_{in2})$	d) None of the mentioned
- 6) What happen if any positive input signal is applied to open-loop configuration?
 - a) Output reaches saturation level
 - b) Output voltage swing's peak to peak
 - c) Output will be a sine waveform
 - d) Output will be a non-sinusoidal waveform
- 7) In 8085 microprocessor, how many interrupts are maskable _____.

a) Two	b) Three
c) Four	d) Five
- 8) In how many different modes a universal shift register operates _____.

a) 2	b) 3
c) 4	d) 5

B) Fill in the blanks OR Write True /False.

04

- 1) The data in stack is called _____.
- 2) _____ Circuit is used as signal source in all sort of application.
- 3) _____ bit program counter is available in 8085.
- 4) The voltage gain of a voltage buffer is _____.

- Q.2 Answer the following. (Any Six) 12**
- a) Define Input offset voltage.
 - b) Draw AND gate with truth table.
 - c) What is the function of IO/M signal in the 8085?
 - d) What is differential amplifier.
 - e) What is dynamic shift register.
 - f) Why op-amp called direct coupled high differential circuit.
 - g) What is microprocessor? Give the power supply & clock frequency of 8085.
 - h) Define CMRR frequency response.
- Q.3 Answer the following. (Any Three) 12**
- a) Explain the timing diagram of 8085.
 - b) Explain Multiplexers and Demultiplexers.
 - c) Write a note on RS flip flop and JK flip flop.
 - d) Explain Inverting and Non inverting amplifier.
- Q.4 Answer the following. (Any Two) 12**
- a) Define Oscillators? Explain their types.
 - b) Write a note on 8085 instruction set.
 - c) Explain in details of instrumentation amplifier.
- Q.5 Answer the following. (Any Two) 12**
- a) Discuss Synchronous and Asynchronous counter.
 - b) Draw and explain 8:1 Multiplexers.
 - c) What is multivibrator? Explain the difference between the three types of multivibrators.

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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Research Methodology in Physics (2307105)

Day & Date: Thursday, 11-01-2024
 Time: 03:00 PM To 05:30 PM

Max. Marks: 60

Instructions: 1) All questions are compulsory.
 2) Figure to right indicate full marks.

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

08

- 1) A researcher is generally expected to _____.
 - a) Study of existing literature in a field
 - b) Generate new principle and theories
 - c) Synthesis the ideas given by others
 - d) Evaluate the finding of a study
- 2) Oxides and Nitrides can be applied by _____ evaporation.
 - a) E-beam
 - b) Thermal
 - c) Magnetron
 - d) DC
- 3) Tuning of the refractive index with the density of the films is possible by sputtering.
 - a) Magnetron
 - b) DC
 - c) Ion beam
 - d) RF
- 4) The main problem in questionnaire is _____.
 - a) Accessible to Diverse Respondent
 - b) Greater Anonymity
 - c) Shows an inability of respondent to provide information
 - d) None of these
- 5) UV-Vis spectroscopy cannot analyze compounds that _____ with light.
 - a) don't interact
 - b) interact
 - c) merge
 - d) none of the above
- 6) Technique that allow several members of a hiring company to interview a job candidate at the same time is _____.
 - a) Panel Interview
 - b) Self-administered interview
 - c) Mail Interview
 - d) Electronic Interview
- 7) The most common scales used in research are _____.
 - a) Nominal
 - b) Ratio
 - c) Ordinal
 - d) All of the above
- 8) By selecting laser operating conditions, control over microstructure is _____.
 - a) possible
 - b) impossible
 - c) not defined
 - d) both a) and b)

- B) Fill in the blanks OR Write True or False: 04**
- 1) In E-beam evaporation, only the target is heated and not the crucible. (True/False)
 - 2) In thermal evaporation, films in the thickness range of angstroms to microns are obtained. (True/False)
 - 3) Applied research is conducted to solve practical problems. (True/False)
 - 4) The basic research is also called as fundamental research. (True/False)
- Q.2 Answer the following. (Any Six) 12**
- a) State the various sampling methods.
 - b) Write the applications of Pulsed Laser Deposition.
 - c) What are the applications of UV-Vis Spectroscopy?
 - d) What are patents?
 - e) Define Quantitative research method.
 - f) Define physical and chemical vapour deposition.
 - g) Write primary literature review sources.
 - h) What are the applications of FTIR Spectroscopy.
- Q.3 Answer the following. (Any three) 12**
- a) Write a note on Descriptive Vs Analytical research methods.
 - b) Differentiate between SEM and TEM techniques.
 - c) Write a note on web as source.
 - d) Write the basic mechanism of sputtering technique.
- Q.4 Answer the following. (Any two) 12**
- a) Define Research? What are characteristics of Research.
 - b) Discuss different type of Research.
 - c) Write a note on Review of Literature.
- Q.5 Answer the following. (Any two) 12**
- a) What is Research Design? What are its essentials
 - b) Write in detail about the concept of Chemical Bath Deposition.
 - c) Explain in detail about Spray Pyrolysis.

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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Mathematical Physics (MSC10101)

Day & Date: Friday, 05-01-2024
 Time: 03:00 AM To 06:00 PM

Max. Marks: 80

Instructions: 1) All questions are compulsory.
 2) Figures to the right indicate full marks.

Q.1 A) Choose correct alternative.

10

- 1) The product of a singular matrix with its adjoint is _____.
 a) a unit matrix b) a null matrix
 c) an orthogonal matrix d) Square matrix
- 2) What is the value of a_0 in the Fourier series of t^2 in the interval $-\pi < t < \pi$?
 a) 0 b) $\pi^2/3$
 c) $\pi^2/8$ d) $\pi^2/4$
- 3) If A and B are orthogonal matrices, then the product AB is _____.
 a) symmetric b) antisymmetric
 c) orthogonal d) unitary
- 4) Evaluate the integral $\int_0^{2\pi} \frac{\sin^2\theta}{5 + 4\cos\theta} d\theta$
 a) 2π b) π
 c) $\pi/2$ d) $\pi/4$
- 5) The value of $\int_{-\pi}^{\pi} \cos(mx) \sin(nx) dx =$
 a) 1 b) -1
 c) 0 d) π
- 6) If $|z^2 - 1| = |z^2| + 1$ then z lies on _____.
 a) the real axis b) the imaginary axis
 c) a circle d) on ellipse
- 7) Find the pole of $f(z) = \sin \frac{1}{(z-a)}$ = _____.
 a) $z = a$ b) $z = 0$
 c) $z = 1$ d) $z = 4$
- 8) In Cauchy's Residues theorem $\oint_{\Gamma} f(z) dz =$ _____.
 a) $2\pi i \sum_{j=1}^n a_{-1} z_j$ b) $2\pi i$
 c) $2\pi i \sum_{j=1}^n a_{+1} z_j$ d) $2\pi i \sum_{j=1}^n z_j$

9) _____ is the real part (Re Z) & _____ is the imaginary (Im Z), of the given $z = (1 + i)/(2 - 3i)$.

a) $-\frac{1}{13}$ & $\frac{5}{13}$

b) $-\frac{1}{11}$ & $\frac{4}{13}$

c) $\frac{1}{3}$ & $-\frac{5}{13}$

d) $\frac{1}{09}$ & $\frac{5}{13}$

10) Legendre polynomial is a set of _____ function.

a) orthogonal

b) odd

c) even

d) real

B) Fill in the blanks OR write true/false.

06

- a) A necessary and sufficient condition that solution y_1 and y_2 of $y'' + p(x)y' + q(x)y = 0$ is linearly independent is that the Wronskian is zero. (True/False)
- b) Fourier series can be used to represent discontinuous where all orders of derivatives need not exist. (True/False)
- c) The Fourier transform operator is unitary.
- d) The first order ODE can never be linear separable and exact at the same time. (True/False)
- e) A Fourier transform is a linear operator. (True/False)
- f) A square matrix is called orthogonal if $A = A^{-1}$. (True/False)

Q.2 Answer the following.

16

- a) If A and B are two orthogonal matrices, show that AB is also orthogonal matrix.
- b) Find the Laplace transform of $\frac{s^2 - a^2}{(s^2 + a^2)^2}$
- c) Find the residue of $\frac{1}{(z^2 + 1)^3}$ at $z = i$
- d) Solve $y e^y dx = (y^3 + 2x e^y) dy$

Q.3 Answer the following.

a) Solve $x \frac{dy}{dx} + y \log y = x y e^x$ **08**

b) Find the eigen value of a matrix $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$ **08**

Q.4 Answer the following.

a) Determine the value of α, β, r when $\begin{bmatrix} 0 & 2\beta & r \\ \alpha & \beta & -r \\ \alpha & -\beta & r \end{bmatrix}$ is orthogonal. **08**

b) Determine the poles of the function z , $f(z) = \frac{1}{z^4 + 1}$ **08**

Q.5 Answer the following.

a) Solve $\sin x \frac{dy}{dx} + 2y = \tan^3\left(\frac{x}{2}\right)$ 08

b) Verify Cayley - Hamilton Theorem for the following matrix. 08

$$A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix} \text{ and use the theorem to find } A^{-1}$$

Q.6 Answer the following.

a) Find the order of each pole and residue of $\frac{1 - 2z}{z(z - 1)(z - 2)}$ 08

b) Show that the eigen value of Hermitian matrix are real. 08

Q.7 Answer the following.

a) In square wave expand the function. 08

$$f(x) = 0; -\pi \leq x \leq 0$$

$$f(x) = 4; -0 \leq x \leq \pi \text{ Fourier.}$$

b) Explain Laplace transform of Derivatives. 08

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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Solid State Physics (MSC10102)

Day & Date: Sunday, 07-01-2024
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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) Effective mass is equal to _____ mass for free electron.
 - a) Mean
 - b) real
 - c) Residual
 - d) zero
- 2) Elemental solid dielectric has only _____ polarization.
 - a) Electronic
 - b) ionic
 - c) orientational
 - d) all
- 3) In the case of p-type semiconductors, the Fermi level lies at _____.
 - a) Below near to conductor band
 - b) Above near to valence band
 - c) Below near to valence band
 - d) At the middle of the valence and conduction band
- 4) In the case of superconductor, at T_c conductance becomes _____.
 - a) Zero
 - b) Finite
 - c) Infinite
 - d) None of the above
- 5) _____ has a positive temperature coefficient of resistance.
 - a) Metal
 - b) Semiconductor
 - c) Insulator
 - d) Dielectric
- 6) The coordination number of HCP is _____.
 - a) Two
 - b) Four
 - c) Six
 - d) Twelve
- 7) Plane cut to negative x-axis have the miller indices _____.
 - a) (011)
 - b) (001)
 - c) (110)
 - d) (-100)
- 8) The zone lies in between $+\pi/2$ to $-\pi/2$ is the _____ Brillion zone.
 - a) 1st
 - b) 2nd
 - c) 3rd
 - d) 0th
- 9) Relative permittivity (ϵ_r) of the air is _____.
 - a) 2
 - b) 0.5
 - c) 1
 - d) 0
- 10) Intrinsic concentration of charge carriers in a semiconductor varies as _____.
 - a) T
 - b) T²
 - c) T³
 - d) 1/T

- B) Fill in the blanks OR Write True or False** **06**
- 1) Some conductors are _____ below critical temperature.
 - 2) FCC structure contains the contribution of _____ atoms.
 - 3) The packing fraction of the BCC structure is 74%. (T/F)
 - 4) NaCl shows orientation polarization. (T/F)
 - 5) Diamond is a conductor. (T/F)
 - 6) The addition of pentavalent impurity creates an n-type semiconductor. (T/F)
- Q.2 Answer the following (any four)** **16**
- a) Write about orientational polarization.
 - b) Explain Meissner's effect.
 - c) Derive the rectifier equation
 - d) Show that in the case of an intrinsic semiconductor $E_f = (E_c + E_v)/2$
 - e) Write a note on dielectric Breakdown.
- Q.3 Answer the following**
- a) What is meant by imperfections in crystals? Explain the various defects in the crystal. **10**
 - b) Explain BCC and FCC Crystal structures. **06**
- Q.4 Answer the following**
- a) Discuss the BCS theory in detail. **10**
 - b) Write a note on the types of superconductors **06**
- Q.5 Answer the following**
- a) Write about the London equation. **08**
 - b) Write the expression for penetration depth. **08**
- Q.6 Answer the following**
- a) Write about Reciprocal Lattice. **10**
 - b) Explain DC Josephson's effect. **06**
- Q.7 Answer the following**
- a) Explain the Kronig-Penney model. **10**
 - b) Give the expression for electronic polarizability. **06**

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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Analog and Digital Electronics (MSC10103)

Day & Date: Tuesday, 09-01-2024
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- Instructions:** 1) All questions are compulsory.
 2) Attempt any three questions from Q.3 to Q.7.
 3) Figure to right indicate full marks.

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

10

- 1) The basic SR flip-flop can be constructed by cross coupling by using which of the gates?
 - a) AND or OR gate
 - b) XOR or XNOR gate
 - c) NOR or NAND gate
 - d) AND or NOR gate
- 2) In JK flip-flop "no change" condition appear when _____
 - a) $J = 1, K = 1$
 - b) $J = 0, K = 0$
 - c) $J = 1, K = 0$
 - d) $J = 0, K = 1$
- 3) Which is the 16-bit register for 8085 microprocessor?
 - a) Stack pointer
 - b) Accumulator
 - c) Register B
 - d) Register C
- 4) The feedback path in an op-amp integrator consists of _____.
 - a) A resistor
 - b) A capacitor
 - c) A resistor and capacitor in series
 - d) A resistor and capacitor in parallel
- 5) Multiplexer has _____
 - a) Many input and one output
 - b) One input many output
 - c) Many input and many out put
 - d) One input and one output
- 6) The op-amp comparator circuit uses _____
 - a) Positive feedback
 - b) Negative feedback
 - c) Regenerative feedback
 - d) No feedback
- 7) Op- amp is a type of amplifier _____
 - a) Current
 - b) Voltage
 - c) Power
 - d) Resistance
- 8) An XOR gate can be used for _____
 - a) Inverter and non-inverter
 - b) Only inverter
 - c) Only non-inverter
 - d) None of the above

- 9) Which of the following addressing method does the instruction, MOV AX,[BX] represent?
 - a) register indirect addressing mode
 - b) direct addressing mode
 - c) register addressing mode
 - d) register relative addressing mode
- 10) Which of the following is a property of RST 7.5 interrupt?
 - a) It is a non-maskable interrupt
 - b) It has 3rd highest priority
 - c) It uses level-triggered signal
 - d) Its vectored address is 003C H

B) Fill in the blanks

06

- 1) In an instrumentation amplifier, the output voltage is based on the _____ times a scale factor.
- 2) The output voltage of a voltage buffer is _____ with the input voltage.
- 3) The voltage gain of a voltage buffer is _____.
- 4) The data in stack is called _____.
- 5) The sequential circuit is also called _____.
- 6) There are _____ general purpose registers in 8085 microprocessor.

Q.2 Answer the following

16

- a) Define
 - i) Input offset voltage
 - ii) Voltage follower
- b) Draw AND gate and NOT gate with truth table.
- c) What is microprocessor? Give the power supply & clock frequency of 8085 and List the allowed register pairs of 8085.
- d) Write a note on Demorgan's Theorem.

Q.3 Answer the following.

- a) Draw and explain architecture of 8085 microprocessor.
- b) Explain Multiplexers and Demultiplexers.

10

06

Q.4 Answer the following.

- a) What is multivibrator? Explain the difference between the three types of multivibrators.
- b) Draw and explain 8:1 Multiplexers.

10

06

Q.5 Answer the following.

- a) Explain the operation of three op-amp instrumentation amplifier.
- b) Define Oscillators? Explain their types.

10

06

Q.6 Answer the following.

- a) Explain inverting configuration of Op amp as a summing, scaling and averaging Amplifier.
- b) Explain Inverting and Non inverting amplifier.

10

06

Q.7 Answer the following.

- a) Explain the instruction set of 8085 microprocessor.
- b) Draw and explain memory read cycle of 8085 microprocessor.

10

06

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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Classical Mechanics (MSC10108)

Day & Date: Thursday, 11-01-2024
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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. 10

- 1) The position of a particle at any time t subjected to resistive force is _____.
 a) $x = k.(1 + e^{-kt})/v_0$ b) $x = kv_0(1 - e^{-kt})$
 c) $x = v_0(1 - e^{-kt})/k$ d) $x = kv_0(1 + e^{-kt})$
- 2) The rate of momentum change of an open system is equal to _____.
 a) $T + MU$ b) $F - MV$
 c) $W - MV$ d) $F + MU$
- 3) The reduced mass of two bodies into equivalent one body is _____.
 a) $(m_1 + m_2)/(m_1.m_2)$ b) $(m_1.m_2)/(m_1 - m_2)$
 c) $m_2/(1 + m_2/m_1)$ d) $m_1/(1 + m_2/m_1)$
- 4) The time derivative of generalized co-ordinate is _____.
 a) Generalized force b) Generalized velocity
 c) Generalized momentum d) None of these
- 5) For $E > 0$ and $\varepsilon > 1$, the nature of the orbit is _____.
 a) Circle b) Parabola
 c) Ellipse d) Hyperbola
- 6) The generalized momentum is equal to _____.
 a) $\partial L/\partial q_j$ b) $\partial L/\partial \dot{p}_j$
 c) $\partial L/\partial \dot{q}_j$ d) $\partial L/\partial p_j$
- 7) Which of the following defines a conservative force F ?
 a) $dF/dt = 0$ b) $\nabla.F = 0$
 c) $\nabla \times F = 0$ d) $\oint F.dr = 0$
- 8) Poisson brackets are _____ under canonical transformation.
 a) Variant b) nullified
 c) anti-symmetric d) invariant
- 9) Generalized coordinated _____.
 a) are independent of each other
 b) depend on each other
 c) are always cartesian coordinates
 d) are always spherical polar coordinates
- 10) The $F_2 = \sum q_k P_k$ transformation defined as _____.
 a) generates exchange transformation
 b) generates identity transformation
 c) is not canonical transformation
 d) None of the above

B) Fill in the blanks or write true /false. 06

- 1) Scleronomic constraint do not explicitly depends on time. (True/False)
- 2) q_j 's which are absent in L are cyclic coordinates. (True/False)
- 3) Rutherford's differentia scattering cross section has dimensions of solid angle. (True/False)
- 4) The Euler-Lagrangian differential equations is _____.
- 5) Lagrangian is equal to _____.
- 6) $[L_x, L_y] =$ _____.

Q.2 Answer the following questions. 16

- a) Which conditions are used to verify that the transformation is canonical? Prove any one condition.
- b) Prove that forces acting on a particle are conservative then the total energy E of a particle is conserved.
- c) Distinguish between the configuration space and phase space.
- d) Define Hamiltonian. Give its physical significance.

Q.3 Answer the following.

- a) Derive the equation of motion of a particle and deduce the acceleration of Atwood machine under constant force. 10
- b) Obtain the equation of motion of 06
 - 1) a particle subjected to a resistive force
 - 2) a projectile (no resistance)

Q.4 Answer the following.

- a) Derive the formula for Rutherford scattering cross-section. 10
- b) Derive an equivalent equation for reduction to one body problem from two body problem. 06

Q.5 Answer the following.

- a) State the Kepler's laws of planetary motion and prove the Kepler's third law. 10
- b) Deduce the Lagrange's equation of motion from Hamilton's principle and using derive the generalized momentum. 06

Q.6 Answer the following.

- a) Derive canonical equations of Hamilton. Also write the procedure for constructing Hamiltonian. 10
- b) Obtain Hamilton's equation for one dimensional harmonic oscillator. 06

Q.7 Answer the following.

- a) State and prove Poisson's theorem. 10
- b) Prove the Jacobi identity $[V, [V, W]] + [V, [W, U]] + [W, [U, V]] = 0$ 06

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M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (SOLID STATE PHYSICS)
Quantum Mechanics (MSC10201)

Day & Date: Monday, 18-12-2023
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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_a and Ψ_b are said to be orthogonal to each other, then which of the following is true.
 - a) $\langle \Psi_a | \Psi_b \rangle = 1$
 - b) $\langle \Psi_a | \Psi_b \rangle = \infty$
 - c) $\langle \Psi_a | \Psi_b \rangle = \sqrt{1/2}$
 - d) $\langle \Psi_a | \Psi_b \rangle = 0$
- 2) If two operators do not commute with each other, then which of following statement is true.
 - a) They do not share common eigenfunction.
 - b) They do share common eigenfunction.
 - c) Their eigenvalues are same.
 - d) They must anti-commute.
- 3) The minimum energy of particle confined to one dimensional rigid box is obtained by substituting n equal to _____.
 - a) one
 - b) zero
 - c) half
 - d) two
- 4) The total energy operator or Hamiltonian operator is given by $H^\wedge =$ _____.
 - a) $\hat{p}^2/2m$
 - b) $V(x)$
 - c) $(\hat{p}^2/2m) + V(x)$
 - d) $(\hat{p}^2/2m) - V(x)$
- 5) Energy of harmonic oscillator is, $E =$ _____.
 - a) $n\hbar\omega$
 - b) $(1/2)\hbar\omega$
 - c) $(n + 1/2)\hbar\omega$
 - d) $(n - 1/2)\hbar\omega$
- 6) The eigen value of L^2 is _____.
 - a) $l(l + 1)\hbar^2$
 - b) $l(l - 1)\hbar$
 - c) $l(l^2 + 1)\hbar^2$
 - d) $l(l + 1)\hbar$
- 7) Which of the following is lowering operator _____.
 - a) $L_x + iL_y$
 - b) $L_x - L_y$
 - c) $L_x - iL_y$
 - d) 0
- 8) The commutation relation between $[x, P_x]$ and $(\partial/\partial x, x)$ is _____.
 - a) $i\hbar, 0$
 - b) $0, i\hbar$
 - c) $-i\hbar, 1$
 - d) $i\hbar, 1$
- 9) Which of the following equation is correct?
 - a) $[\hat{y}, \hat{p}_z] = i\hbar$
 - b) $[\hat{x}, \hat{p}_y] = i\hbar$
 - c) $[\hat{z}, \hat{p}_x] = i\hbar$
 - d) $[\hat{z}, \hat{p}_z] = i\hbar$

10) Which of the following equations is/are correct?

- i) $K = r \times p$
 ii) $L = iL_x + jL_y + kL_z$
 iii) $L^2 = L \cdot L$
 iv) $L^2 = L_x^2 + L_y^2 + L_z^2$
- a) i and ii only b) iii and iv only are correct
 c) i, ii and iv are correct d) All are correct

B) Fill in the blanks or Write True /False.

06

- 1) Diffraction and interference are the evidence of wave nature of matter. (True/False)
- 2) Eigen values of Hermitian operator are not real. (True/False)
- 3) Inner product of Bra and Ket in Quantum mechanics is always 1. (True/False)
- 4) For a free particle the potential energy $V(x) = \underline{\hspace{2cm}}$.
- 5) Potential energy of a particle in harmonic oscillator having mass m is $\underline{\hspace{2cm}}$.
- 6) The linear momentum operator is given by $\underline{\hspace{2cm}}$.

Q.2 Answer the following.

16

- a) Normalize the following wave- function in one- dimension:
 $\psi(x) = Ae^{-ax}$ for $x > 0$
 $= Ae^{+ax}$ for $x < 0$
 where α is a positive constant.
- b) Prove that eigen function of Hermitian operator with different eigen values are orthogonal to each other.
- c) Explain unitary transformation.
- d) Define the different postulate of Quantum mechanics.

Q.3 Answer the following.

- a) Derive the time independent Schrödinger equation in 3D.
- b) Deduce the continuity equation.

10

06

Q.4 Answer the following.

- a) Obtain Schrödinger's wave equation for Hydrogen atom in terms of spherical polar coordinates, express its radial and angular parts.
- b) Define angular momentum and explain the commutation relation.

10

06

Q.5 Answer the following.

- a) What is momentum eigen function in the co-ordinate representation? Elaborate.
- b) Write down the co-ordinate and momentum representation.

10

06

Q.6 Answer the following.

- a) What is the Clebich Gordon coefficient? Explain the construction procedure. With simple examples.
- b) Describe the Pauli spin matrices.

10

06

Q.7 Answer the following.

- a) Define square well potential in one dimension. Discuss motion of a particle of mass m when energy of the particle is less than potential ($E < V_0$).
- b) Obtain eigen values of operators L^2 and L_z .

10

06

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Set P

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

Day & Date: Tuesday, 19-12-2023
Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- Instructions:** 1) Q. No. 1 and 2 are compulsory.
2) Attempt any Three questions from Q.No.3 to Q.No.7.
3) Figures to the right indicate full marks.

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

- Divergence of the curl of any vector field is always _____.
 - 0
 - 1
 - Infinite
 - cant possible
- Which one of the fundamental equation was modified by Maxwell to form the basis of electromagnetic theory?
 - Faraday law
 - Ampere law
 - Gauss law of electrostatic
 - Gauss law of magnetostatic
- Lorentz electric force has direction _____.
 - Similar to electric field
 - Opposite to electric field
 - Scalar quantity
 - None
- The Poynting vector P is equal to _____.
 - $E \cdot H$
 - $E \times H$
 - E/H
 - H/E
- Which property of an electromagnetic wave, depends on the medium in which it is travelling?
 - Velocity
 - Frequency
 - Time period
 - Wave length
- In the skin definition of skin depth, it is distance over which field amplitude reduces to _____.
 - Nearly one fifth
 - $1/e$
 - One half
 - One fourth
- In Maxwell equation $\nabla \times H = J + \partial D / \partial t$, J is _____.
 - Electric flux density
 - magnetic flux density
 - Surface current density
 - No physical quantity

Q.6 Answer the following.

- a) Derive the general expression for electromagnetic energy. **10**
- b) Discuss Electromagnetic plane waves in stationary medium? **06**

Q.7 Answer the following.

- a) Explain the concept of radiation from a half wave antenna. **10**
- b) What is Gauss law? Explain differential form of its. **06**

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Set **P**

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

Day & Date: Wednesday, 20-12-2023
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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 from the options. 10

- 1) Which law of thermodynamics is the law of conservation of energy?
 - a) First
 - b) Second
 - c) Zero
 - d) Third
- 2) The phase space is _____ dimensional space.
 - a) 3N
 - b) 6N
 - c) N
 - d) 2N
- 3) The statistics followed by half spin particles is _____.
 - a) Maxwell-Boltzmann Statistics
 - b) Fermi-Dirac Statistics
 - c) Bose-Einstein Statistics
 - d) None of the above
- 4) Maxwell-Boltzmann statistics cannot be applied to _____.
 - a) Atoms
 - b) Molecules
 - c) Photons
 - d) Lattice
- 5) The equation of state for an ideal gas is represented as _____.
 - a) $PV = R/T$
 - b) $PV = nRT$
 - c) $P/V = R/T$
 - d) $PV = RT$
- 6) The entropy of an ideal gas at absolute zero is _____.
 - a) ∞
 - b) 0
 - c) Nk_B
 - d) Cannot be calculated
- 7) For which gas mutual interaction between the molecules is zero.
 - a) real
 - b) Fermi
 - c) Ideal
 - d) Bose
- 8) Total heat of the substance is also known as _____.
 - a) Internal energy
 - b) Entropy
 - c) Thermal Capacity
 - d) Enthalpy
- 9) Pressure at the critical point is _____.
 - a) $3b$
 - b) $8/27R$
 - c) $3b/27Rb$
 - d) $8a/27Rb$

- 10) In microcanonical ensembles following parameters remain constant.
- | | |
|----------|------------|
| a) TVN | b) EVN |
| c) EVT | d) $EV\mu$ |

B) Fill in the blanks OR write true/ false. 06

- 1) The ratio of the universal gas constant and Avogadro's number is called the velocity constant.
- 2) The transition in β -brass is an example of a second-order phase transition.
- 3) Photon, Phonon, etc. obeys the Fermi Dirac distribution function.
- 4) Entropy in thermodynamics is a measure of the disorder of the system.
- 5) The value of the universal gas constant is 8.3143
- 6) A phase space is a six-dimensional space.

Q.2 Answer the following. 16

- a) State the types of ensembles and point out the difference between canonical and Grand Canonical Ensemble.
- b) Discuss the conditions for phase equilibrium.
- c) Show that during the second order phase transition $\partial^2 G_1 / \partial T^2 \neq \partial^2 G_2 / \partial T^2$.
- d) What is a partition function? Derive it for Canonical Ensemble.
- e) Explain the P-T diagram of the phase transaction.

Q.3 Answer the following.

- a) Show that Gibb's function is continuous during the first-order phase transition, but the first derivative of Gibb's function changes discontinuously. 10
- b) What is a triple point? Explain it with the help of a phase diagram. 06

Q.4 Answer the following.

- a) Write a note on Critical Indices 10
- b) Write about Liouville's theorem in a classical presentation. 06

Q.5 Answer the following.

- a) Write about Second order phase transition. 08
- b) Write a note on microcanonical, canonical and grand canonical ensembles. 08

Q.6 Answer the following.

- a) Show that the average energy of a single particle of ideal fermi gas is $3/5$ times the fermi energy of the system. 10
- b) Explain the law of corresponding states. 06

Q.7 Answer the following.

- a) Derive the expression for Fermi energy at strongly degenerate ideal Fermi gas. 10
- b) Write about black body radiation. 06

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Set **P**

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

Day & Date: Friday, 05-01-2024

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) When a piece of pure silicon is doped with indium, then _____.
 - a) The doped silicon piece will become n-type semiconductor
 - b) The doped silicon piece will become p-type semiconductor
 - c) The conductivity of the doped silicon piece will remain the same
 - d) The resistivity of the doped silicon piece will increase
- 2) Compound semiconductors such as GaAs have _____.
 - a) ionic bonding
 - b) metallic bonding
 - c) covalent bonding
 - d) mixed bonding, in which both ionic and covalent bonding forces participate.
- 3) Which of the following semiconductor has indirect band gap?

a) Ge and GaAs	b) Si and GaAs
c) GaAs	d) Ge and Si
- 4) In direct electron transition _____.
 - a) there is no change in momentum of electron
 - b) there is no change in momentum of electron
 - c) there is change in propagation vector, k of the electron
 - d) electron jumps from an impurity level to the conduction band
- 5) An intrinsic semiconductor at absolute zero temperature (0 K) has _____.
 - a) an empty valence band and an empty conduction band
 - b) a filled valence band and filled conduction band
 - c) a filled valence band and an empty conduction band
 - d) an empty valence band an a filled conduction band
- 6) _____ is the initial process that occurs in the formation of a crystal.

a) Growth	b) Nucleation
c) atomic bonding	d) Clusters

- 7) _____ is the series of process by which an atom or molecule is incorporated into the surface of crystal.
 - a) crystal growth
 - b) Nucleation
 - c) Clusters
 - d) atomic bonding
- 8) Epitaxial techniques have been used for the growth of epilayers of III-V, II-VI compound _____ and other materials.
 - a) metals
 - b) insulators
 - c) semiconductors
 - d) plasma
- 9) Czochralski method is crystal growth of _____.
 - a) growth from melt
 - b) growth from vapor
 - c) growth from solution
 - d) growth from solid
- 10) The driving force needed for the nucleation and growth of crystal is referred as _____.
 - a) nucleation force
 - b) supersaturation
 - c) growth force
 - d) molecular force

Q.1 B) Fill in the blanks OR write True /False 06

- 1) In a semiconductor, most holes occupy states near the bottom of the valence band.
- 2) A semiconductor with band gap of about 2 eV wide, allows only long wavelengths (infrared) and the red part of the visible spectrum to transmit through it.
- 3) Electrons are distinguishable and obey Pauli Exclusion Principle.
- 4) First step in crystal growth is transport of atoms through solution.
- 5) Epitaxy means growth of many crystal films on top of a crystalline substrate.
- 6) Molecular beam epitaxy is a process of depositing epitaxial thin films from molecules or atomic beams on a heated substrate under UHV conditions.

Q.2 Answer the following. 16

- a) Discuss random thermal velocity and drift velocity of charge carriers in a semiconductor.
- b) Distinguish between direct and indirect band gap semiconductors.
- c) What is nucleation rate and induction time?
- d) Write advantages of epitaxial techniques.

Q.3 Answer the following. 16

- a) Discuss electrical conductivity and mobility in a semiconductor.
- b) What is principle of vapor phase epitaxy? Explain with neat diagram vapor phase epitaxy.

Q.4 Answer the following. 16

- a) Discuss bonding forces in solids.
- b) What is liquid phase Epitaxy? Explain with neat diagram the liquid phase epitaxy.

- Q.5 Answer the following.** **16**
- a) Discuss in detail “Effective mass” of an electron in a band.
 - b) Explain the theory of nucleation and growth.
- Q.6 Answer the following.** **16**
- a) Discuss diffusion process of charge carriers in a semiconductor.
 - b) With neat diagram, discuss zone melting method of crystal growth with advantages.
- Q.7 Answer the following.** **16**
- a) Discuss in detail “The Haynes-Shockley Experiment.”
 - b) With neat diagram, discuss Czochralski method of crystal growth. Mention advantages and disadvantages of the method.

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

Day & Date: Sunday, 07-01-2024
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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) Multiple choice questions. **10**

- 1) In computing the splitting of spectral lines in a weak magnetic field the Lande g-factor arises because of _____.
 - a) Pauli Exclusion Principle
 - b) spin-orbit coupling
 - c) Larmor precession
 - d) relativistic correction
- 2) Laser cooling of atoms is produced due to _____.
 - a) Absorption of photons by atoms
 - b) scattering of photons by atoms
 - c) Transfer of momentum from photon to atoms
 - d) transfer of energy from photons to atoms.
- 3) First Raman shifted line observed at 218 cm^{-1} for CCl_4 excited by 632.8nm of He-Ne laser, will correspond to scattered wavelength at (given $h=6.6 \times 10^{-34} \text{Js}$ $c=3 \times 10^8 \text{m/s}$)
 - a) 128.5nm
 - b) 621.8nm
 - c) 5000.0nm
 - d) 641.6 nm
- 4) The outermost shell of an atom of an element is $3d^3$. The spectral symbol for the ground state
 - a) ${}^4F_{3/2}$
 - b) ${}^4F_{9/2}$
 - c) ${}^4D_{7/2}$
 - d) ${}^4D_{1/2}$
- 5) A negative muon, which has a mass nearly 200 times that of an electron, replaces an electron in a Li atom. The lowest ionization energy for the muonic Li atom is approximately.
 - a) The same as that of He
 - b) The same as that of normal Li
 - c) The same as that of normal Be
 - d) 200 times larger than that of normal Li
- 6) Which of the following molecules does not exhibit a rotational spectrum.
 - a) HCl
 - b) CO
 - c) H_2
 - d) HBr
- 7) JJ coupling is the _____ Coupling.
 - a) Weak
 - b) strong
 - c) less weak
 - d) none of these
- 8) One electron in P orbit and another in a D orbit, in case of LS coupling, the atom may be in a _____ state.
 - a) SPD
 - b) PDF
 - c) DFG
 - d) Only D

- 9) Which of the following molecule will not show the microwave spectra.
a) CH₂Cl₂ b) SF₆
c) H₂O d) CH₃Cl
- 10) The lowest vibrational energy is given by _____.
a) $\frac{1}{2} \omega$ b) ω
c) $\frac{1}{2} \omega^2$ d) ω^2

B) Fill in the blanks or True false from give parenthesis 06

- 1) _____ Detector is an IR detector (crystal / Pyroelectric)
- 2) At J=0 i.e ground rotational state, in which the _____ (rotation / no rotation)
- 3) Intensity rule for the Zeeman effect of the atomic systems containing more than one valance electron is _____ of type of coupling (dependent /Independent)
- 4) When L is greater than or equal to S, all integral Value of J between L-S and L+S are allowed.
- 5) Hyperfine structures arises in tungsten due to presence there even isotopes tungsten.
- 6) The spherical top molecule have dipole moment owing to their symmetry.

Q.2 Answer the following. 16

- a) Give selection rule for LS and JJ coupling
- b) State and explain the intensity rule for Zeeman Effect.
- c) Distinguish between normal and anomalous Zeeman Effect.
- d) Find the spectroscopic term for npl,np2,np4,np5.

Q.3 Answer the following.

- a) With the schematic diagram, write the construction and working of stern gerlach experiment. 12
- b) The spin orbit coupling constant for the upper state of Na atom which emits D lines for weak numbers 16959cm⁻¹ and 1697.4cm⁻¹ is? 04

Q.4 Answer the following.

- a) What are the assumption made for the deriving an expression for Lande 'g' factor? Obtain the expression for the Lande 'g' factor for LS coupling. 12
- b) In a hydrogen atom the accidental or coulomb degeneracy for the n=4 state is? {111}. 04

Q.5 Answer the following.

- a) Write the consequences for bond elasticity for diatomic molecule as a non-rigid rotator. 12
- b) The number of Zeeman component for 2D_{3/2} --> 2P_{3/2} transition in one electron atom will be?{124} 04

Q.6 Answer the following.

- a) Discuss the techniques and instrumentation of microwave spectrometer and its use in chemical analysis 12
- b) The land's g factor for the ³P₁ level of an atom is? {91}. 04

Q.7 Answer the following.

- a) Draw the vibrational energy levels and some transition between them for a diatomic molecules undergoing anharmonic oscillations 12
- b) Consider a state in which l=4, s=1/2 the orientation of total angular moment w.r.t Cos 45 the state with largest possible J, mj is? {55} 04

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

Day & Date: Tuesday, 09-01-2024
Time: 11:00 AM To 02:00 PM

Max. Marks: 80

- 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 alternatives.

10

- 1) Dielectrics which show spontaneous polarization are called as _____.
a) Pyroelectric b) Piezoelectric
c) Ferroelectric d) Centrosymmetric
- 2) For a given gas at sufficiently low pressures, the thermal conductivity _____ with pressure.
a) Decreases b) increases
c) remains constant d) first decreases then increases
- 3) Resolution of SEM is approximately _____.
a) 1 mm b) 1 μm
c) 1 nm d) 1 cm
- 4) X-rays are generated by _____.
a) Geiger tube b) Goniometer
c) Coolidge tube d) Rotameter
- 5) The CMRR of an in-amp will be around _____.
a) 50dB b) 50dB
c) 240dB d) 120dB
- 6) The resolving power of TEM is derived from _____.
a) electrons b) specimens
c) power d) ocular system
- 7) A device which converts a physical quantity into the proportional electrical signal is called a _____.
a) transducer b) sensor
c) transistor d) none of these
- 8) The thermogravimetric analysis (TGA) technique is used to measure _____ with temperature.
a) Electrical conductivity b) mass
c) thermal expansion d) specific heat
- 9) The wavelength in an FTIR spectrometer controlled by _____.
a) Michelson Interferometer.
b) a computer
c) a laser
d) calibration with a standard sample.

- 10) LED is a PN junction diode under _____ biased.
- forward
 - reversed
 - both forward as well as reverse
 - not any

B) Fill in the blanks OR write true/ false. 06

- In SEM, convex lens is used for focussing electrons.
- In electromagnetic spectrum, the infrared region is located between the visible and microwave region.
- Raman lines are weak.
- When a molecule absorbs infrared radiation then molecule vibrate slower.
- The differential scanning calorimetry technique is used to measure specific heat with temperature.
- The basic material for optical fibre is silicon.

Q.2 Answer the following 16

- Explain the working of getter ion pump.
- Write the advantages of four probe method over two probe method.
- What is sensor. Discuss different types of sensors.
- Explain the working of LCR meter.

Q.3 Answer the following 16

- Explain in details construction and working of transmission electron microscopy.
- What is shielding. Discuss types of shielding.

Q.4 Answer the following 16

- Explain the working of piraniguage.
- Explain the working of linear variable differential transformer LVDT.

Q.5 Answer the following 16

- Discuss various method used for obtaining low temperature.
- Explain the working of oil diffusion pump.

Q.6 Answer the following 16

- Explain the working of X-ray diffraction method for the analysis of crystal structure.
- Explain the working of atomic force microscopy with suitable diagram.

Q.7 Answer the following 16

- What is Ruby Laser? Explain the working of Ruby Laser with suitable diagram.
- Explain the working principle of differential scanning calorimetry (DSC).

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Set **P**

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

Day & Date: Monday, 18-12-2023
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- Instructions:** 1) Attempt five questions.
 2) Question No.1 and 2 are compulsory.
 3) Attempt any three from Q. No. 3 to Q. No. 7.

Q.1 A) Choose correct alternatives. 10

- 1) A CCD involves ____ actions.
 - a) charge storage and transfer
 - b) only charge transfer
 - c) only storage
 - d) charge storage and loss
- 2) Two valley model of TEDs based on GaAs is proposed by _____.
 - a) BCS
 - b) BBS
 - c) RWH
 - d) NWH
- 3) LEDs fabricated with GaAs emit _____ wavelength.
 - a) far ultra violet
 - b) ultraviolet
 - c) visible
 - d) infrared
- 4) An overlapping gate structure is used for improving ____ performance.
 - a) CCD
 - b) LED
 - c) LASER
 - d) SCR
- 5) Photodetector _____ optical signal.
 - a) reflects
 - b) detects
 - c) modulate
 - d) amplify
- 6) The M - S structure forms _____ barrier.
 - a) schottky
 - b) read
 - c) ohmic
 - d) non – ohmic
- 7) $(\alpha_1 + \alpha_2)$ approaches _____ when the SCR devices are at forward breakdown.
 - a) 100
 - b) 1000
 - c) ∞
 - d) 1
- 8) A Triacs is used where the transfer of large _____ is involved.
 - a) Power
 - b) voltage transfer
 - c) electron transfer
 - d) charge transfer

- 9) In a CCD operation the thermal relaxation time is _____ than the charge storage time.
 - a) longer
 - b) much longer
 - c) shorter
 - d) much shorter
- 10) Light emission is not possible in Si due to its _____.
 - a) direct band gap
 - b) high mobility
 - c) indirect band gap
 - d) doping

B) Fill in gaps/State True or False **06**

- 1) Refreshing circuit is incorporated in CCD memory as it provides _____.
- 2) Pulsed laser can deliver very _____ power.
- 3) The M-S structure forms _____ barrier.
- 4) The CCD devices are static.
- 5) The forward characteristic of a Shockley diode is useful for switching.
- 6) PUT requires 2 V if gate is biased at 0.8 V.

Q.2 Answer the following. **16**

- a) Programable UJT.
- b) Enhancement type MOSFET.
- c) Dynamic effect in CCD.
- d) Radiative and non-radiative transitions.

Q.3 a) Describe the operating principle of photodiode based on PN junctions, pin configuration and multilayer heterojunction with. band diagrams and IV characteristics. **10**

- b) Draw block diagram, doping profile, electric field distribution in p-i-n diode. **06**

Q.4 a) Give an account of DIAC and TRIAC with suitable diagrams and IV characteristics. **10**

- b) Explain di/dt protection. **06**

Q.5 a) Describe MS structure with band diagram. **10**

- b) Charge trapping in MOSFET. **06**

Q.6 a) Describe GaAs Gunn Oscillator modes in terms of **10**

- i) Space charge accumulation
- ii) Quenched domain mode
- iii) Delayed domain mode

- b) Explain current flow mechanism in MS junction. **06**

Q.7 a) Describe IV characteristics of solar cell. Derive an expression for quantum efficiency of solar cell. **10**

- b) How performance of CCD is improved. **06**

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

Day & Date: Tuesday, 19-12-2023
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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 binding energy of deuteron is _____.
 - a) 13.6 eV
 - b) 36 MeV
 - c) 2.225 MeV
 - d) 13.6MeV
- 2) The range of energy _____ eV is called as epithermal reaction.
 - a) 1eV
 - b) 0.025eV
 - c) 1KeV
 - d) 0.1-1MeV
- 3) The simplest two nucleon system exist in nature is of _____.
 - a) n-n
 - b) n-p
 - c) p-p
 - d) dose not exist
- 4) the height of potential barrier faced by an alpha particle inside the nucleus is _____.
 - a) 31.2MeV
 - b) 31.2KeV
 - c) 31.2GeV
 - d) 31.2eV
- 5) The energy equivalent to 1 a m u is _____.
 - a) 931 eV
 - b) 931 KeV
 - c) 931 MeV
 - d) 93 BeV
- 6) The compound nucleus ha life time is of the order of _____.
 - a) 10^{-8} Sec
 - b) 10^{-11} Sec
 - c) 10^{-14} Sec
 - d) 10^{-21} Sec
- 7) Unit of cross section is _____.
 - a) Fermi
 - b) barn
 - c) MeV
 - d) nucleon per cm³
- 8) Semi empirical mass formula for the binding energy of nucleus contains a surface correction term this term depends on the mass number A of the nucleus
 - a) $A^{-1/3}$
 - b) $A^{2/3}$
 - c) $A^{1/3}$
 - d) A
- 9) The electric quadruple moment is negative, shape of the nuclei is _____.
 - a) Oblate
 - b) Prolate
 - c) Spherical
 - d) All of these
- 10) The _____ Can explain magic number.
 - a) Liquid drop model
 - b) Fermi gas model
 - c) shell model
 - d) All of these

- B) Fill in the blanks / True or False. 06**
- 1) Nuclear binding energy usually expressed in units of _____
 - 2) The exchange particle which holds the quarks together is called _____.
 - 3) In direct reaction incident particle completely have more than _____ Energy per nucleon
 - 4) Cross sectional area of n-p scattering is $4\pi a^2$ (T/F)
 - 5) In a deuteron, the force between neutron and proton is short range and repulsive (T/F)
 - 6) Nucleons are bosons (T/F)
- Q.2 Answer in brief. 16**
- a) Discuss shape and size, mass and relative abundances of nucleus.
 - b) Discuss superconductivity model.
 - c) Write a note on conservation laws.
 - d) Write a note on cosmic ray.
- Q.3 Answer the following. 10**
- a) Derive an expression for scattering cross section of two nucleon system and write a note on scattering length. 10
 - b) Discuss properties of nuclear forces. 06
- Q.4 Answer the following. 10**
- a) Describe liquid drop model of nucleus point out its usefulness and limitations in understanding the nuclear phenomenon. 10
 - b) Explain the energy levels of shell model. How this helps to explain the occurrence of magic numbers? Draw the diagram. 06
- Q.5 Answer the following 10**
- a) Explain the nuclear reaction kinematics Obtain an expression for Q value discuss the general solution of the Q equation. 10
 - b) Comment on compound nuclear disintegration. 06
- Q.6 Answer the following 10**
- a) Give the Gell-Mann-Nisijima relation and calculate the charge of baryon family using this relation find out strangeness' and hypercharge of the baryon octet plot the schematic diagram and table. 10
 - b) Discuss quark hypothesis and quantum chromodynamics. 06
- Q.7 Answer the following 10**
- a) What should be the minimum KE of the electrons to probe the size of ${}_{20}\text{Ca}^{40}$ nucleus. 10
 - b) An ${}_{8}\text{O}^{16}$ nucleus is spherical and has charge radius R and volume according to empirical observation of the charge radii, the volume of the ${}_{54}\text{Xe}^{128}$ nucleus assume to be spherical what is the ratio of volume of Xe to the volume of Oxygen. 06

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

Day & Date: Wednesday, 20-12-2023
 Time: 03:00 PM To 06:00 PM

Max. Marks: 80

- 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 alternative.

10

- 1) Chemical vapour 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) _____ 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) Thin film growth in which small nuclei are formed over the surface of substrate is called _____.
 - a) nucleation
 - b) growth
 - c) film
 - d) substrate
- 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) _____ can be produced by reacting dichlorosilane and ammonia at temperature between 700°C and 800°C.
 - a) silicon dioxide
 - b) silicon nitride
 - c) silicon dinitride
 - d) polysilicon
- 9) Silicon nitride is often used as an _____ and chemical barrier in manufacturing ICs.
 - a) solid
 - b) insulator
 - c) semiconductor
 - 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) Fill in the blanks OR Write True / False 06

- 1) LASER evaporation is the process by which the source material is evaporated by using focused e - beam. True / False
- 2) Spray pyrolysis is chemical deposition technique. True / False
- 3) Energies of the order of _____ correspond to physical adsorption.
- 4) Thin film deposition is the process of creating and depositing thin film coatings onto a substrate material. 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 _____.

Q.2 Answer the following. 16

- a) What are the factors affecting synthesis of Nanoparticles?
- b) Explain dielectric deposition.
- c) Explain Polysilicon CVD reaction.
- d) Write thin film deposition mechanism in chemical bath deposition.

Q.3 Answer the following. 10

- a) Explain with neat diagram of the RF Sputtering Process. 10
- b) Explain polysilicon deposition. 06

Q.4 Answer the following. 10

- a) Explain electrodeposition technique of deposition of thin films with its mechanism. 10
- b) Write a note on Metallization. 06

Q.5 Answer the following. 08

- a) Explain with neat diagram plasma enhanced chemical vapor deposition. What are its advantages and disadvantages? 08
- b) With neat diagram, explain formation stages of thin film. 08

Q.6 Answer the following. 10

- a) Explain thin film transistor with its characteristics. 10
- b) Explain dielectric properties of thin film. 06

Q.7 Answer the following. 10

- a) Describe laser evaporation method for depositing thin film. What are its advantages? 10
- b) Discuss conduction properties in metal thin film. 06

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M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023

PHYSICS (SOLID STATE PHYSICS)

Materials Characterization Techniques (MSC10406)

Day & Date: Thursday, 21-12-2023

Max. Marks: 80

Time: 03:00 PM To 06:00 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) To enhance _____ is crucial in electron microscopy.
 - a) vacuum requirements
 - b) resolution
 - c) electron wavelength
 - d) numerical aperture
- 2) _____ detector is used in SEM to capture the electrons emitted from surface of sample.
 - a) Backscattered electron detector
 - b) Secondary electron detector
 - c) Fluorescence detector
 - d) Transmission electron detector
- 3) What is one solution to the limitation of tunneling current fluctuations in STM?
 - a) Increase the tip-sample distance
 - b) Decrease the tip-sample distance
 - c) Maintain constant tip-sample distance
 - d) Change the electron wavelength
- 4) AFM measures the _____ between the tip and the sample.
 - a) Magnetic force
 - b) Gravitational force
 - c) Mechanical force
 - d) Van der Waals force
- 5) What does Bragg's condition describe in electron diffraction?
 - a) Absorption of electrons
 - b) Refraction of electrons
 - c) Interference of electrons
 - d) Diffraction of electrons
- 6) In XPS, the binding energy of a photoelectron is directly related to the _____.
 - a) Surface roughness
 - b) Atomic number
 - c) Electron configuration
 - d) Sample thickness
- 7) In AES, the energy of Auger electrons corresponds _____.
 - a) Atomic number
 - b) Electron configuration
 - c) Core level splitting
 - d) Auger transitions
- 8) Quantum mechanical calculations in NMR are used to predict _____.
 - a) Magnetic field strength
 - b) Spin states of nuclei
 - c) Electron configuration
 - d) Chemical bonding
- 9) The hyperfine structure in EPR arises from the interaction between _____.
 - a) Electrons and protons
 - b) Electrons and electrons
 - c) Nuclei and electrons
 - d) Nuclei and photons
- 10) In NMR spectra, chemical shifts are expressed in units of _____.
 - a) Hertz (Hz)
 - b) Parts per million (ppm)
 - c) Tesla (T)
 - d) Joules (J)

- Q.1 B) Write True /False. 06**
- 1) Continuous wave-EPR involves continuously irradiating a sample with microwave radiation while measuring the resulting absorption or emission signals.
 - 2) Hyperfine structure in ESR spectroscopy arises from interactions between the electron and nearby nuclear spins.
 - 3) Quantum mechanical calculations are essential for predicting the behavior of nuclear spins in NMR spectroscopy.
 - 4) Ultra-High Vacuum (UHV) is not necessary in surface characterization to minimize interactions with residual gases.
 - 5) STM is limited by its inability to image non-conductive samples.
 - 6) Fluorescence microscopy is a technique that uses the property of certain substances to emit light when exposed to specific wavelengths.
- Q.2 Answer the following. 16**
- a) Describe the concept of Magic-Angle Spinning (MAS) in the context of NMR.
 - b) Explain the concept of a surface in the context of material science.
 - c) Discuss advantages and disadvantages of Scanning Electron Microscope (SEM).
 - d) Explain the principle of operation of Transmission Electron Microscopy (TEM) and highlight the role of electron beams in imaging.
- Q.3 Answer the following. 16**
- a) Discuss the instrumentation, experimental conditions, and applications of this EPR technique.
 - b) Explore the Zeeman interaction in the context of the NMR signal which influences the resonance frequencies observed in NMR spectra.
- Q.4 Answer the following. 16**
- a) Explain the challenges and methods involved in achieving quantitative analysis using Auger Electron Spectroscopy and Discuss the factors influences on accuracy of quantitative results.
 - b) Explore recent advancements in surface analysis techniques. Discuss how these innovations have improved the capabilities and applications of both XPS and AES in material science.
- Q.5 Answer the following 16**
- a) Explain principle, instrumentation and working of atomic force microscope.
 - b) Draw the schematic diagram of XPS and explain the its working of each part.
- Q.6 Answer the following 16**
- a) Describe the lens systems in a Transmission Electron Microscope (TEM) and how these lenses contribute to the magnification and resolution of the images obtained in TEM.
 - b) Explain how the phase contrast and differential interference contrast techniques enhance the visibility of transparent specimens in optical microscopy.
- Q.7 Answer the following 16**
- a) Outline the components of an optical column in electron microscopy.
 - b) Explain Raman Spectroscopy with the help of classical and quantum approach