

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.

$$y \log y dx + (x - \log y) dy = 0$$

Seat No.	
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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Solid State Physics (2306102)

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

Seat No.	
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M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Analog and Digital Electronics (2306106)

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.

Seat No.	
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Set **P**

M.Sc. (Semester - I) (New) (NEP CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Research Methodology in Physics (2306105)

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.

Seat No.	
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Set **P**

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Mathematical Physics (MSC09101)

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) $2\pi i \sum_{j=1}^n z_j$

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

Seat No.	
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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Solid State Physics (MSC09102)

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**

Seat No.	
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M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Analog and Digital Electronics (MSC09103)

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**

Seat
No.

M.Sc. (Semester - I) (Old) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Classical Mechanics (MSC09108)

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) $x = k \cdot (1 + e^{-kt})/v_0$
 - 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) $(m_1 + m_2)/(m_1 \cdot m_2)$
 - b) $(m_1 \cdot m_2)/(m_1 - m_2)$
 - 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) $\nabla \cdot F = 0$
 - c) $\nabla \times F = 0$
 - d) $\oint F \cdot dr = 0$
- 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

Seat No.	
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M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Atomic, Molecular Physics (MSC09302)

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 632.8 nm 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) 128.5 nm b) 621.8 nm
 c) 5000.0 nm 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

- 10) The relation of crystal growth rate is _____.
- $\frac{dr}{dt} = \frac{D(C_h - C_i)}{rd_m}$
 - $\frac{dr}{dt} = \frac{D(C_h - C_i)}{r}$
 - $\frac{dr}{dt} = \frac{D(C_h - C_i)}{d_m}$
 - $\frac{dr}{dt} = \frac{r(C_h - C_i)}{D}$

B) Fill in the blanks OR Write true or false.**06**

- The layer-by-layer assembly of oppositely charged polyelectrolytes originated in the early.
- Quantum dots have two dimensions. (True/False)
- Carbon atom can form four covalent bonds. (True/False)
- Bucky ball is an example of _____.
- The electrospinning process can be adjusted to control fibre diameter by varying electric field strength and polymer solution concentration. (True/False)
- The range of identical Temperature for synthesis of MOF is 500°C to 600°C. (True/False)

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

- Discuss basic material used for Polymer Nanocomposites.
- Explain the applications of quantum dots in Biomedicine.
- Write the short on the structural properties of TiO₂ Nanotube arrays.
- What are properties of polymer Nanocomposites.

Q.3 Answer the following

- Discuss the fabrication process of TiO₂ nanotube arrays by electrochemical anodization with First synthesis generation. **08**
- What are structural applications nanocomposite fibre? **08**

Q.4 Answer the following

- Write in detail Electrospinning Process for Nanofibres. **08**
- Explain the synthesis method of semiconductor Nanocrystal in organic solvent. **08**

Q.5 Answer the following

- Define Metal Oxide Frameworks. Write down its advantages and disadvantages. **08**
- Explain in detail. Arc discharge and Arc melting synthesis method of Boron Nitride Nanotube. **08**

Q.6 Answer the following

- What is polymerisation? Explain Emulsion polymerisation. **08**
- Describe Layer-by-Layer (LBL) assembly with semiconductor Nanoparticles and nanowires. **08**

Q.7 Answer the following

- What are the key processing parameters of Electrospinning process of Nanofibre and explain any four key parameters in detail. **10**
- Write the short on the fabrication techniques of Polymer Nanocomposites. **06**

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M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Semiconductor Devices (MSC09401)

Day & Date: Monday, 18-12-2023
 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) Select the correct alternative.

12

- 1) In Schottky diode, the junction is in between _____.
 - a) N-type & P-semiconductor
 - b) N-type semiconductor and metal
 - c) no junction
 - d) P-type semiconductor and metal
- 2) D-MOSFET works in _____.
 - a) enhancement mode only
 - b) depletion mode only
 - c) both enhancement and depletion mode
 - d) none of these
- 3) The voltage above which E-MOSFET works is known as _____ voltage.

a) threshold	b) knee
c) firing	d) breakdown
- 4) _____ type of SCR fires by incident light.

a) IGBT	b) GTO
c) DIAC	d) LASCR
- 5) Which of the following power semiconductor device is unipolar?

a) SCR	b) TRIAC
c) IGBT	d) Power MOSFET
- 6) The minimum current required to keep SCR in on state is known as _____.

a) hold in current	b) saturation current
c) leakage current	d) hold in current
- 7) Which of the following device works in negative resistance region?

a) Zener diode	b) Light Emitting Diode
c) Varactor diode	d) Gunn diode
- 8) In MIS capacitor, the inversion layer is formed in _____.

a) metal	b) insulator
c) semiconductor	d) silicon dioxide layer
- 9) The formula for the frequency in GHz in Gunn diode is given by _____.
 (Where L is in micrometer)

a) $100/L$	b) $10/L$
c) $100*L$	d) $10*L$

- 10) The LASER light is _____.
 - a) parallel beam
 - b) monochromatic
 - c) coherent
 - d) all of these
- 11) If the energy of incident radiation is greater than band gap energy then _____.
 - a) only electrons are created
 - b) only holes are created
 - c) both electrons and holes are created
 - d) none of these
- 12) _____ produces maximum current for incident photon of light.
 - a) photo cell
 - b) LDR
 - c) avalanche photo detector
 - d) photo diode

B) State True or False

04

- 1) MIS structure in MOSFET works as inductor.
 - a) True
 - b) False
- 2) Gunn diode contains no PN junction.
 - a) True
 - b) False
- 3) TRIAC conducts in both direction.
 - a) True
 - b) False
- 4) GaP is used in light emitting diode.
 - a) True
 - b) False

Q.2 Answer the following.

16

- a) Write a note on MIS capacitor.
- b) With neat diagram explain the construction of DIAC.
- c) Explain the working of light activated SCR.
- d) Explain the working of PN junction photodetector.

Q.3 Answer the following.

- a) Explain the I-V characteristics of D-MOSFET and hence define parameters of D-MOSFET. **08**
- b) Explain the of Schottky barrier between the metal and semiconductor. Why it is working as rectifying contact? **08**

Q.4 Answer the following.

- a) Explain with neat diagram the construction and working of SCR. Define their ratings. **10**
- b) Explain with necessary graph the I-V characteristic of DIAC. **06**

Q.5 Answer the following.

- a) Explain the mechanism of charge transfer in three phase CCD. **10**
- b) Write a note on TT and LSA operating mode of Gunn diode. **06**

Q.6 Answer the following.

- a) Explain the construction and working of heterojunction LASER. **08**
- b) Explain quantum efficiency, response speed, noise and optical absorption coefficient of photodetector. **08**

Q.7 Answer the following.

- a) Explain the Gunn effect on the basis of two valley model. **08**
- b) Explain the construction and working of gate turn off (GTO) SCR. **08**

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M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Nuclear and Particle Physics (MSC09402)

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

Max. Marks: 80

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

Q.1 A) Choose correct alternative.

10

- 1) Nuclear force is _____.
 - a) Spin dependent
 - b) charge dependent
 - c) both charge and spin independent
 - d) spin dependent but charge independent
- 2) The asymmetry term in semi empirical mass formula is due to _____.
 - a) Non spherical shape of the nucleus
 - b) Non zero spin of the nucleus
 - c) Unequal number of protons and neutrons
 - d) equal number of protons and neutrons
- 3) A nucleus with 235 splits into two nuclei whose mass numbers are in ratio 2:1, then radii of the two new nuclei is (given $R_0 = 1.4\text{fm}$)

a) 5.89fm, 6.55fm	b) 5.99fm, 7.55fm
c) 6.89fm, 7.66fm	d) 1.23fm, 3.12fm
- 4) Which of the following has high penetrating power?

a) Alpha particles	b) protons
c) gamma rays	d) beta particles
- 5) The mass difference between the nucleus and its constituents nucleons is called the _____.

a) Packing fraction	b) binding energy
c) mass conservation	d) mass defect
- 6) In the distribution of cosmic ray, the latitude effect is maximum at _____.

a) Equator of Earth	b) pole of earth
c) 45° latitude	d) -15° latitude
- 7) Cyclotron is used to accelerate

a) Neutral particles	b) negative ions
c) positive ions	d) both b and c
- 8) GM counter cannot detect the _____.

a) Protons	b) neutrons
c) beta particles	d) alpha particles

- 9) Which of the following is not correct statement
- A deuteron can be disintegrated by irradiating it with gamma rays of energy 4 MeV.
 - A deuteron has no excited states.
 - A deuteron has no electric quadrupole moment.
 - The 1S_0 state of deuteron cannot be formed.
- 10) The electromagnetic reactions are _____.
- C - conserving
 - C - non conserving
 - CP Non conserving but CPT conserving
 - CPT Non conserving

B) Write True or false.

06

- According shell model set of magic numbers is 2,8,20,28,50,82,126.
- Isospin and third component of Isospin of proton is $1/2$, $1/2$ respectively.
- Proton is made up of the two down and one up quarks.
- Baryon number of e^+ and e^- are 0, 0 respectively.
- Beta decays is the process of transition between two isobars.
- Eigen values of the parity operator are +1 and -1.

Q.2 Answer the following.

16

- What is radioactivity? Explain the decays scheme in nuclides in brief.
- Explain the basic properties (mass, size, shape, spin, binding energy etc.) of the nucleus.
- What are the types of nuclear reactions. Comment on the conservation laws of nuclear reactions.
- Describe the scintillation counter.

Q.3 Answer the following.

- a) Derive the semi empirical mass formula. Discuss the advantages and disadvantages of liquid drop model.

08

- b) classify the elementary particles. Write short notes of conservation laws in elementary particles.

08

Q.4 Answer the following.

- a) What are the cosmic rays. Explain the latitude effect and east- west asymmetry.

08

- b) Explain the nuclear shell model in details. Hence derive the expression for correction energy term due to spin-orbit interaction.

08

Q.5 Answer the following.

- a) What are the particle accelerator? Explain the principle and working of cyclotron.

08

- b) Deduce the expression for Q value in nuclear reactions. Give its physical significance.

08

Q.6 Answer the following.

- a) Derive the expression for the atomic number of stable isobar using the liquid drop model. Hence solve the following problem find the stable isobar nuclide $A=125$ (given $a_c = 0.7\text{MeV}$ and $a_{\text{sym}} = 22.5\text{MeV}$).

08

- b) Derive the expression for the Q value in alpha decays. Solve following problem Consider the spontaneous emission of alpha decay from ${}_{92}\text{U}^{232}$ Find the kinetic energy of alpha particle, if the energy Q is released.

08

Q.7 Answer the following.

- A)** What are the particle detectors. Write short notes on **08**
- a) Scintillation detector
 - b) Semiconductor detector
- B)** Explain the following each type of nuclear reactions with example **08**
- a) Direct reactions
 - b) Nuclear transformation reaction
 - c) Nuclear fission
 - d) Nuclear fusion

Seat No.	
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M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANO PHYSICS)
Characterization of Nano Materials (MSC09403)

Day & Date: Wednesday, 20-12-2023
 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 correct alternative. 10

- 1) _____ with energy dispersive X-ray analysis (EDAX) is a very useful tool for qualitative & semi quantitative analysis of elements.
 - a) Scattering electron Microscopy
 - b) Scattering ion Microscopy
 - c) Scanning electron Microscopy
 - d) Scanning ion Microscopy
- 2) The energy dispersive X-ray spectroscopy (EDX or EDS) is technique used in analytical electron microscopy to determine _____ of the material.
 - a) Elemental composition
 - b) Morphology
 - c) Particle size
 - d) Particle shape
- 3) Which of the following are true for electron microscopy?
 - a) Specimen should be thin and dry
 - b) Image is obtained on phosphorescent screen
 - c) Electron beam must pass through evacuated chamber
 - d) all of the above
- 4) Raman shift depends upon _____.
 - a) Incident intensity
 - b) Incident wavelength
 - c) Resolving power of spectrograph used
 - d) molecule energy level of scatterer
- 5) Young's modulus of perfectly rigid body is _____.
 - a) Unity
 - b) Negative
 - c) Infinity
 - d) Zero
- 6) What is the wavelength range for UV spectrum of light?
 - a) 400 nm - 700nm
 - b) 700 nm -10mm
 - c) 0.01 nm -10 nm
 - d) 10 nm - 400 nm
- 7) What are the two the main technique for thermal analysis?
 - a) FTG & DGG
 - b) TGA & DTA
 - c) MSP and FCT
 - d) TSA and DGF
- 8) Raman effect is scattering of _____.
 - a) Elastic scattering of photon
 - b) Elastic scattering of electron
 - c) Inelastic scattering of photon by molecule
 - d) Inelastic scattering of proton

Seat No.	
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M.Sc. (Semester - IV) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANO PHYSICS)
Nano Material Fabrication Techniques (MSC09408)

Day & Date: Thursday, 21-12-2023
 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) Select correct alternative from following. **10**

- 1) Microscope that uses light rays to produce a dark image against a bright background is known as a _____.
 a) brightfield microscope b) Darkfield microscope
 c) electron microscope d) Phase contrast microscope
- 2) The characterization of Auger spectroscopy can be achieved up to which of the following depths?
 a) 2 nm b) 1nm
 c) 4 nm d) 8nm
- 3) Electromagnetic energy is kept constant in.
 a) Continuous wave NMR b) Fourier Transform NMR
 b) Both a& b d) discontinues wave NMR
- 4) _____ types of waves has the shortest frequency?
 a) X-ray b) Radio waves
 c) Microwave d) UV
- 5) Which of the following wave has the shortest wavelength?
 a) Radio waves b) Visible
 c) X-Ray d) Infrared
- 6) Resolving Power of microscope is depends on wavelength as _____.
 a) λ b) $1/\lambda$
 c) $1/\lambda^2$ d) λ^2
- 7) Bending of light around a edge of obstacle and enters in shadow region is called _____.
 a) Diffraction b) Interference
 c) Polarization d) Reflection
- 8) Basic principle of STM is _____ tunneling
 a) Classical b) Semi- classical
 c) quantum d) Both a and c
- 9) Which among the following microscopes uses light as the source of illumination?
 a) Stereomicroscope b) electron microscope
 c) SEM d) TEM

- 10) NMR is the study of absorption of _____ by nuclei in a magnetic field.
- Radioactive Radiation
 - IR Radiation
 - Radio frequency Radiation
 - Microwaves

B) Answer True/ False.**06**

- In optical microscopy electromagnetic lenses are used.
- Auger electron spectrum is plot of intensity versus kinetic energy.
- A microscope of objective focal length 1 cm and an eyepiece of focal length 2.0 cm has a tube length of 20 cm. then magnification of the microscope is 250.
- AES is limited when it comes to very high resolution studies.
- Signal splitting in NMR arises from spin- spin decoupling.
- Electron spectroscopy is based on the ionization phenomenon.

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

- Write the notes on Electron microscopy
- Explain the necessity of Ultra high vacuum in X- ray photoelectron spectroscopy.
- Write down the application of AUGER Electron spectroscopy.
- Discuss the NMR spectra

Q.3 Answer the following.**16**

- What is airy disk and explain how the Rayleigh criteria used for limit of resolution.
- Sketch and briefly describe the operating principles of the atomic force microscopy.

Q.4 Answer the following.**16**

- State the limitation of optical microscopy. Write the advantages of electron microscopy over optical microscopy.
- Explain the principle, operation, working of XPS

Q.5 Answer the following.**16**

- Write note on contact and non contact modes of STM.
- What are type of resonance spectroscopy? Write properties of nuclear spins.

Q.6 Answer the following.**16**

- Draw neat labeled diagram of Auger Electron Spectroscopy regarding following points
 - electron energy analyzer
 - electron detector
 - electron optical column
- Explain in detail principle, construction and working of AFM.

Q.7 Answer the following.**16**

- Explain in detail principle, construction and working of STM.
- Write down applications of STM in detail.

Seat No.	
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M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Quantum Mechanics (MSC09201)

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) $[\hat{z}, \hat{p}_z] = i\hbar$

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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M.Sc. (Semester - II) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Statistical Physics (MSC09206)

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) $8a/27Rb$

SLR-EV-21

- 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

Seat
No.

M.Sc. (Semester - III) (New) (CBCS) Examination: Oct/Nov-2023
PHYSICS (NANOPHYSICS)
Semiconductor Physics (MSC09301)

Day & Date: Friday, 05-01-2024
 Time: 11:00 AM To 02:00 PM

Max. Marks: 80

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

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

- 1) In a semiconductor, the energy gap between the valence band and conduction band is about _____.
 - a) 5 eV
 - b) 10 eV
 - c) 15 eV
 - d) 1 eV
- 2) Electron-hole pairs are produced by _____.
 - a) Recombination
 - b) Thermal energy
 - c) Ionization
 - d) Doping
- 3) The drift velocity of the conductor _____.
 - a) Increase with an increase in temperature
 - b) Decrease with Decrease in temperature
 - c) Increase with Decrease in the temperature
 - d) Decrease with the increase in temperature
- 4) In Schottky barrier, barrier height depends on _____.
 - a) Amount of doping material
 - b) Type of doping material
 - c) Temperature
 - d) None of the above
- 5) The probability that an electron in a metal occupies the fermi level, at any temperature ($> 0K$) is _____.
 - a) 0
 - b) 1
 - c) 0.5
 - d) 1.0
- 6) If σ is the conductivity, what is the relation between the electric field E and the current density J in a conducting medium?
 - a) $\sigma = J/E$
 - b) $\sigma = 1/JE$
 - c) $\sigma = E/J$
 - d) $\sigma = EJ$
- 7) The equilibrium number of EHP in pure Si at room temperature is about _____.
 - a) 10^{10} EHP/cm³
 - b) 10^{12} EHP/cm³
 - c) 10^{10} EHP/m³
 - d) 10^{12} EHP/m³
- 8) The atoms of solid are held together by _____.
 - a) Van der Waals forces
 - b) Hydrogen bonds
 - c) Ionic bonds
 - d) Hydrophobic forces
- 9) What is the role of seed crystal in crystal growth?
 - a) Nucleation center
 - b) Catalyst
 - c) Solvent
 - d) Solution

- 10) Charge carriers can move in semiconductor via:
- Diffusion mechanism
 - Floating mechanism
 - Drift mechanism
 - Both drift and diffusion mechanism

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

- The mean lifetime of electron-hole pair (EHP) is less than _____ seconds.
- LED is an example of _____ luminescence.
- _____ nuclei often redissolve.
- Nucleation poses large energy barrier. (True/False)
- Mobility cannot be determined from Haynes-Shockley experiment. (True/False)
- Debye temperature is associated with the highest allowed mode of vibration. (True/False)

Q.2 Answer the following 16

- Write a note on optical absorption.
- Explain fermi level pinning.
- Write a short note on group velocity of electrons.
- Explain in short direct bandgap semiconductors.

Q.3 Answer the following

- Elaborate in detail about the ohmic contacts. 10
- Explain in short about Nucleation process. 06

Q.4 Answer the following

- Explain the concept of vibrational specific heat and derive its expression. 10
- Write in brief about inverse effective mass tensor. 06

Q.5 Answer the following

- Elaborate in detail about the growth of bulk semiconductors by Zone Melting. 10
- Explain in brief about surface and interface states. 06

Q.6 Answer the following

- Explain the concept of steady state carrier generation. 10
- Write in brief about vapour phase epitaxy. 06

Q.7 Answer the following

- Explain in detail about rectifying contacts with the necessary band diagrams. 10
- Explain the bonding forces in solids. 06