SLR-JO-291

Seat No.	

Set P

M.Sc. (Semester – I) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
MATHEMATICAL TECHNIQUES

Day & Date: Monday, 18-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Which of the following is an analytic function of the complex variable $z = x + iy$ in the domain $|z| < 2$?
   a) $(3 + x - iy)^7$ b) $(1 + x + iy)^4\ (7 - x - iy)^3$
   c) $(1 - x - iy)^4\ (7 - x + iy)^3$ d) $(x + iy - 1)^{\frac{1}{2}}$

2) Let $u(x, y) = x + \frac{1}{2}(x^2 - y^2)$ be the real part of analytic function $f(z)$ of the complex variable, $z = x + iy$. The imaginary part of $f(z)$ is _____.
   a) $y + xy$ b) xy
   c) y d) $y^2 - x^2$

3) If C is the contour defined by $|z| = \frac{1}{2}$, the value of the integral $\oint_c \frac{dz}{\sin^2 Z}$ is _____.
   a) ∞ b) $2\pi i$
   c) 0 d) πi

4) The Cauchy – Riemann equation in polar form is given as _____.
   a) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}\ and\ \frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ b) $\frac{\partial u}{\partial r} = r\frac{\partial v}{\partial \theta}\ and\ \frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$
   c) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}\ and\ \frac{1}{r}\frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$ d) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}\ and \frac{1}{r}\frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$

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

6) A unitary matrix is defined by the expression: _____.
   a) $U = U^T$, where superscript T means transpose
   b) $U = U^\dagger$
   c) $U = U^*$
   d) $U^{-1} = U^\dagger$

7) Any set of linearly independent vectors can be orthonormalized by the _____.
   a) Pound – smith procedure b) Gram – Schmidt procedure
   c) Sobolev method d) Sobolev – P method

8) What are the eigenvalues 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

9) The differential equation of all parabolas having axis parallel to y- axis is _____.

a) $\frac{d^3x}{dy^3} = 0$ b) $\frac{d^3y}{dx^3} = 0$

c) $\frac{d^3y}{dx^3} + \frac{d^2y}{dx^2} = 0$ d) $\frac{d^2y}{dx^2} = 0$

10) The degree of $x\frac{d^2y}{dx^2} + \sin\frac{dy}{dx} = 0$ is _____.

a) 1 b) 2

c) 3 d) Not defined

11) Which of the following is an "even" function of t?

a) $t^2 - 4t$ b) $t^3 + 6$

c) t^2 d) $\sin(2t) + 3t$

12) What are the conditions required for a signal to fulfill to be represented as Fourier series?

a) Dirichlet's conditions b) Gibbs phenomenon

c) Fourier conditions d) Fourier phenomenon

13) Which of the following pairs of the given function f(t) and it's Laplace transform f(s) is NOT CORRECT?

a) $f(t) = \delta(t), f(s) = 1, (singularity\ at + 0)$

b) $f(t) = 1, f(s) = {}^{1}/_{s}, (s > 0)$

c) $f(t) = \sin kt, f(s) = \frac{s}{s^2 + k^2}, (s > 0)$

d) $f(t) = t\,e^{kt}, f(s) = \frac{1}{(s-k)^2}, (s > k, s > 0)$

14) The Fourier transform $\int_{-\infty}^{\infty} dx\, f(x)e^{ikx}$ of the function $f(x) = \frac{1}{x^2+2}$ is ___.

a) $\sqrt{2}\pi e^{-\sqrt{2}|k|}$ b) $\sqrt{2}\pi e^{-\sqrt{2}K}$

c) $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}K}$ d) $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}|K|}$

Q.2 A) Answer the following questions. (Any Four) **08**

1) Find the solution of the differential equation. $\frac{d^2y}{dx^2} - 7\frac{dy}{dx} + 6y = 0$

2) Classify the singularities and calculate the residue for $f(z) = \frac{A(z)}{\sin Z}$, where $A(z)$ is analytic and contains no zeros.

3) Find the eigenvectors of $H = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

4) Expand $f(x) = x$ for $-\pi \le x \le \pi$ in a Fourier series.

5) From the convolution theorem show that

$$\frac{1}{s}f(s) = \mathcal{L}\left\{\int_0^t F(x)dx\right\}$$

Where $f(s) = \mathcal{L}\{f(t)\}$

B) Write short notes. (Any Two) **06**

1) The Cauchy Principal Value
2) Properties of Fourier series
3) Linear dependent and independent set of vectors

Q.3 A) Answer the following questions. (Any Two) **08**

1) Show that the eigenvalues of a Hermitian matrix are all real.
2) State and prove Cauchy's Integral theorem.
3) Solve the differential equation $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 2\cos x$

B) Answer the following (Any One) **06**

1) Using partial fraction expansion, show that for $a^2 \neq b^2$,

$$\mathcal{L}^{-1}\left\{\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right\} = \frac{1}{a^2-b^2}[a\sin(at) - b\sin(bt)]$$

2) By use of the residue theorem, evaluate $\int_0^{2\pi} \frac{d\theta}{(a+b\cos\theta)^2}$

where $a > b > 0$.

Q.4 A) Answer the following questions. (Any Two) **10**

1) Find the eigenvalues and eigenvectors of $A = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
2) Find the Fourier transform of Gaussian distribution functions.
3) Solve the differential equation, $y^3\frac{dy}{dx} + \frac{1}{x}y^4 = x$

B) Answer the following questions. (Any One) **04**

1) If $f(x) = x + x^2$ is expanded in a Fourier series then show that

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

2) Find the value of integral $P\int_{-\infty}^{\infty} \frac{e^{ix}}{x}dx$

Q.5 Answer the following questions. (Any Two) **14**

a) Develop the Fourier expansion for $f(t) = \begin{matrix} \sin\omega t & 0 \le \omega t \le \pi \\ -\sin\omega t & -\pi \le \omega t \le 0 \end{matrix}$

b) Find a matrix s that diagonalizes.

$$A = \begin{pmatrix} 3 & -2 & 0 \\ -2 & 3 & 0 \\ 0 & 0 & 5 \end{pmatrix}$$

c) By use of the three-dimensional Fourier transform method, solve poisson's equation for the electrostatic potential function.

$$\nabla^2\phi(\vec{r}) = -\frac{\varrho(\vec{r})}{\in}$$

SLR-JO-292

Seat No.	

Set P

M.Sc.(Semester – I) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
CONDENSED MATTER PHYSICS

Day & Date: Tuesday, 05-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Relative permittivity (ε_r) of the air is _____.
   a) 2 b) 0.5
   c) 1 d) 0

2) Reciprocal lattice vector G = _____.
   a) K'-K b) K - K '
   c) K ' + K d) $(K'+K)^2$

3) The electronic polarizability α_e of a monoatomic gas is _____.
   a) $4\pi\varepsilon_0$ b) $4\pi\varepsilon_0 R$
   c) $4\pi\varepsilon_0 R^3$ d) $4\pi\varepsilon_0^2$

4) Elemental solid dielectric has only _____ polarization.
   a) electronic b) ionic
   c) orientational d) all

5) The Fermi energy of intrinsic semiconductor is _____.
   a) $\frac{Ec+Ev}{2}$ b) $\frac{Ec+Ed}{2}$
   c) $\frac{Ec-Ev}{2}$ d) $\frac{Ec+Ea}{2}$

6) Number of tetrad axis in simple cubic system are_____.
   a) 2 b) 3
   c) 4 d) 8

7) Plane cut to negative x axis have the miller indices _____.
   a) 011 b) 001
   c) 110 d) 100

8) Which of the following cannot actually move?
   a) Majority carriers b) Ions
   c) Holes d) Free electron

9) Effective mass is equal to _____ mass for free electron.
   a) mean b) real
   c) residual d) zero

10) In an _____ polarization, electronic cloud is coming to one side to form dipole.
   a) orientational b) ionic
   c) electronic d) optical

11) FCC structure contains the contribution of _____ atoms.
   a) Two b) four
   c) nine d) six

12) In monoclinic lattice _____ are equal.
a) a, b, c b) α, β, γ
c) h, k, l d) none of these

13) Conductivity in metal depends on _____ mobility.
a) proton b) neutron
c) electron d) none of these

14) Penetration depth varies with _____.
a) pressure b) temperature
c) volume d) width

Q.2 A) Answer the following (Any Four) **08**
1) Define packing fraction.
2) Define coordination number.
3) What is dielectric loss?
4) What is penetration depth?
5) What is rectification?

B) Write short notes (Any Two) **06**
1) Brillion zones.
2) Effective mass of the electron.
3) Schottky barrier.

Q.3 A) Answer the following (Any Two) **08**
1) Derive the rectifier equation.
2) Write about orientational polarization.
3) Explain thermal properties of the superconductor.

B) Answer the following (Any One) **06**
1) Explain dielectrics loss angle and power factor.
2) Explain the defects in solids.

Q.4 A) Answer the following (Any Two) **10**
1) Show the absence of fivefold symmetry.
2) Explain Missner's effect.
3) Write about Reciprocal Lattice.

B) Answer the following (Any One) **04**
1) Distinguish direct and indirect band gap semiconductors.
2) Write about London equation.

Q.5 Answer the following (Any Two) **14**
a) Write about the behavior of electron in a periodic potential.
b) Give the theory of DC Josephson's effect.
c) Give the expression for inter planer spacing (d).

SLR-JO-293

Seat No.	

Set P

M.Sc. (Semester - I) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
ANALOG & DIGITAL ELECTRONICS

Day & Date: Thursday, 07-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

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

Q.1 Fill in the blanks by choosing correct alternatives. **14**

1) In a differential amplifier, the configuration is said to be an 'unbalanced output', if _____
   a) Output voltage is measured between two collectors
   b) Output is measured with respect to ground
   c) Two input signals are used
   d) All the above

2) An ideal operational amplifier has _____
   a) infinite output impedance b) zero input impedance
   c) infinite bandwidth d) all of the above

3) Another name for a unity gain amplifier is _____
   a) difference amplifier b) comparator
   c) single ended d) voltage follower

4) What should be the value of input resistance for an ideal voltage amplifier circuit?
   a) Zero b) Unity
   c) Infinity d) Unpredictable

5) The use of negative feedback _____
   a) reduces the voltage gain of an Op-amp
   b) makes the Op-amp oscillate
   c) makes linear operation possible
   d) answers (a) and (b)

6) Hartley oscillator is commonly used in _____
   a) Radio receivers b) Radio transmitters
   c) TV receivers d) None of the above

7) A Wein-bridge oscillator uses which feedback?
   a) only positive b) only negative
   c) both negative and positive d) none of the above

8) Circuit which consist of a quasi-stable state is called _____
   a) bistable circuit b) monostable circuit
   c) tri stable circuits d) tristate circuit

9) What is the range of the voltage level of the LM317 adjusted voltage regulator?
   a) 0 V to 5 V b) 1.2 V to 37 V
   c) -5 V to -24 V d) 5 V to 24 V

10) Simplify Y = AB'+ (A' + B) C
   a) AB' +C
   b) (A + B') (C'+D)
   c) (A'+B) (C'+D)
   d) (A+B') (C+D')

11) The EXCLUSIVE NOR gate is equivalent to which gate followed by an inverter.
   a) OR
   b) AND
   c) NAND
   d) XOR

12) The basic latch consists of _____
   a) two inverters
   b) two comparators
   c) two amplifiers
   d) two adders

13) Which is the 16-bit register for 8085 microprocessor?
   a) stack pointer
   b) accumulator
   c) register B
   d) register C

14) A bus connected between the CPU and main memory that permits transfer of information between main memory and CPU is known as _____
   a) DMA bus
   b) memory bus
   c) address bus
   d) control bus

Q.2 A) Answer the following questions. (Any Four) **08**

1) Define open loop and closed loop amplifier circuits.
2) Explain CMRR.
3) Explain the conditions of the sustainable oscillator.
4) Define AND gate. Write its logic symbol and truth table.
5) State and prove De Morgan's theorem.

B) Write Notes. (Any Two) **06**

1) Fixed regulators.
2) Explain the concept of virtual ground.
3) Dual input balance output differential amplifier.

Q.3 A) Answer the following questions. (Any Two) **08**

1) Discuss the effect of feedback on closed loop gain.
2) Draw the circuit diagram and output wave forms of triangle wave generator.
3) Explain registers in 8085.

B) Answer the following question. (Any One) **06**

1) Derive an expression for input resistance and bandwidth of voltage series negative feedback amplifier.
2) Write logic diagram and truth table of RS flip flop and explain its working.

Q.4 A) Answer the following questions. (Any Two) **10**

1) A phase shift oscillator uses register R=220 Ohms, what should be the capacitance value if the capacitor required for a phase shift oscillator of frequency of 120 Hz and 1 KHz.
2) Derive an expression for output resistance with feedback in a closed loop amplifier.
3) Write an assembly language program to add two 8 bit numbers.

B) Answer the following questions. (Any One) **04**

1) Derive an expression for op. amp as integrator.
2) With a neat circuit diagram explain switching regulator.

Q.5 Answer the following questions. (Any Two) **14**

1) With a near circuit diagram explain master slave JK flip flop.

2) With a near circuit diagram explain the working of LC tunable shift oscillator.

3) Write an assembly language program for 2's complement of two 16-bit numbers.

SLR-JO-295

Seat No.	

Set P

M.Sc.(Semester – II) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
QUANTUM MECHANICS

Day & Date: Monday, 04-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Classically, the concept of "tunneling" is impossible. Why?
   a) The kinetic energy of the particle would be negative
   b) The total energy of a particle is equal to the kinetic and potential energies
   c) The kinetic energy must be equal to the potential energy
   d) The total energy for the particle would be negative

2) When a particle approaching a potential step has a total energy that is greater than the potential step, what is the probability that the particle will be reflected?
   a) P < 0 b) P = 0
   c) P = 1 d) P > 0

3) A particle has a total energy that is less than that of a potential barrier, when the particle penetrates the barrier, it's wave function is _____.
   a) A positive constant b) Exponentially decreasing
   c) Exponentially increasing d) Oscillatory

4) A rigid diatomic molecule is free to rotate in a fixed plane. The rotational energy eigen values are given by _____.
   a) $\frac{\hbar \mathrm{m}^2}{2\mathrm{I}}$ b) $\frac{2\mathrm{mI}}{\hbar^2}$
   c) $\frac{\hbar^2 \mathrm{I}}{2\mathrm{m}}$ d) $\frac{\mathrm{mI}}{2\hbar^2}$

5) The degree of degeneracy for 3-D isotropic harmonic oscillator is _____.
   a) n^2 b) $2n+1$
   c) $\left(n+\frac{1}{2}\right)(2n+2)$ d) $\frac{1}{2}(n+1)(n+2)$

6) An electron is an infinite square well that is 9.6 nm wide. The electron makes the transition from the n=14 to the n=11 state. The wavelength of the emitted photon is closet to _____.
   a) 3400 nm b) 4100 nm
   c) 2800 nm d) 4700 nm

7) How does the probability of an electron tunneling through a potential barrier vary with the thickness of the barrier?
   a) It is independent of the barrier thickness
   b) It decreases exponentially with thickness
   c) It decreases inversely with thickness
   d) It decreases sinusoidally with thickness

8) For partial described by the wave function $\psi(x,t)$
   a) $|\psi(x_0,t)|^2$ is the probability of finding the particle at x_0
   b) The prob. of finding the particle between x_0 and x_0+dx is proportional to $|\psi(x_0,t)|^2$
   c) The prob. of finding the particle at x_0 is either 0 or 1.
   d) No information can be given about the particle's position.

9) Probability current density $\vec{J}(x,t)$ is always _____.
   a) A real quantity.
   b) A purely imaginary quantity.
   c) Can be either real or purely imaginary depending on $\psi(x,t)$
   d) A complex quantity with possibly non-vanishing imaginary part.

10) The ionization potential of hydrogen atom is 13.6 volt. The energy required to remove an electron from the second orbit of hydrogen is _____.
   a) 3.4 eV b) 6.8 eV
   c) 13.6 eV d) 27.2 eV

11) The de-Broglie hypothesis associated with _____.
   a) Wave nature of electrons only
   b) Wave nature of ∝-particles only
   c) Wave nature of radiations
   d) Wave nature of all material particles

12) The de-Broglie wavelength of material particles which are in thermal equilibrium at temperature T is _____.
   a) $h/(2mKT)^{\frac{1}{2}}$ b) $\hbar/(2mKT)^{\frac{1}{2}}$
   c) $\hbar/(mKT)^{\frac{1}{2}}$ d) $\hbar/(2KT)^{\frac{1}{2}}$

13) In case of wave function, $\psi = \frac{e^{ikr}}{r}$; the probability current density is _____.
   a) $\frac{V}{r}$ b) $\frac{V}{r^2}$
   c) $\frac{V}{r^3}$ d) V

14) The wave function in the ground state of hydrogen atom is given as-
   $\psi = A\, e^{-\frac{r}{a}}$
   r: Measures distance from nucleus and
   a: Constant
   The Value of A is _____.
   a) $1/\sqrt{\pi a}$ b) $1/\sqrt{\pi a^3}$
   c) $1/a\sqrt{\pi}$ d) $1/\sqrt{\pi a^5}$

Q.2 A) Answer the following questions.(Any Four) **08**

1) Explain the terms :
   i) Stationary state
   ii) Bound state
2) Calculate the de-Broglie wavelength of a 0.05 eV ("thermal") neutron.
3) What is the interpretation of wave function ψ?
4) Show that the product of two hermitian operators is hermitian if they commute.

5) Calculate the mean value of the potential energy experienced by an electron in the 1s-orbital of the hydrogen atom.

B) Write notes (Any Two) **06**

1) Third postulates of quantum mechanics.
2) Linear operator and commutator.
3) One Dimensional Box.

Q.3 A) Answer the following questions.(Any Two) **08**

1) Show that if ψ is an eigen function of operator $\hat{A}$ with the eigen value a, then it is also an eigen function of exp(A) with eigen value exp(a).
2) Consider an electron in a macroscopic box of size, a = 2 cm.
   i) What value of n corresponds to energy of 1.5 eV? **02**
   ii) What is the difference in energies of the state n and n+1 in that energy region? **02**
3) Discuss the tunneling for a potential barrier in 1 – D.

$$v(x) = \begin{cases} 0 & \ldots\ldots x < 0 \\ \dfrac{A}{x} & \ldots\ldots x > 0 \end{cases}$$ (A: a +ve constant)

B) Answer the following questions.(Any One) **06**

1) How does the electronic structure of many - electron atoms can be qualitatively explained in terms of hydrogen like orbitals.
2) Show that a particle in a 1 - D box cannot have a definitely known momentum that the average value of the momentum is zero.

Q.4 A) Answer the following questions.(Any Two) **10**

1) Establish the following indentifies for the Dirac δ - function.
   i) $x\,\delta'(x) = -\delta(x)$
   ii) $\delta(x^2 - a^2) = \frac{1}{2|a|}[\delta(x-a) + \delta(x+a)]; a \neq 0$ and is real constant
2) A particle moves in a spherically symmetric attractive potential,
   $V(r) = \begin{cases} -V_0 & \ldots\ldots r < a \\ 0 & \ldots\ldots r > a \end{cases}$ $(V_0 > 0)$
   Obtain the bound state solutions to the Schrödinger equation if $l = 0, l \neq 0$. Is there always a bound - state guaranteed.
3) Discuss the normalization and the characteristics of the Eigen functions of a Harmonic oscillator.

B) Answer the following questions.(Any One) **04**

1) Explain the space Quantization of Electronic orbits.
2) Discuss the many-electron atom with the help of probability density as a function of distance from the nucleus.

Q.5 Answer the following questions.(Any Two) **14**

a) Discuss the case of molecular orbitals of the heteronuclear diatomic molecules.
b) What is the Hydrogen Molecule Ion? Explain in detail.
c) How does the Hartree and Hartree - Fock self-consistent field methods are helpful to estimate the ground state energy and wave functions of many electron atoms? Explain.

Seat No.	

Set **P**

M.Sc. (Semester – II) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
ELECTRODYNAMICS

Day & Date: Wednesday, 06-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) The electrostatic potential (v) due to octopole varies as _____.
   a) $v \sim \frac{1}{r^2}$ b) $v \sim \frac{1}{r^3}$
   c) $v \sim \frac{1}{r^4}$ d) $v \sim \frac{1}{r^1}$

2) The energy (U) of an ideal dipole having dipole moment P in electric field E is given by _____.
   a) $U = -P.E$ b) $U = B.E$
   c) $U = -q.E$ d) $U = q.E$

3) Which of the Maxwell's following equations is corrected on the basis of equation of continuity _____.
   a) $\nabla.E = \frac{\rho}{\epsilon_0}$ b) $\nabla.B = 0$
   c) $\nabla \times E = -\frac{\partial B}{\partial t}$ d) $\nabla \times B = \mu_0 J + \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$

4) Maxwell's equation, $\nabla.B = 0$ is obtained from _____.
   a) Gauss law in electro-statics
   b) Faraday law in electromagnetic induction
   c) Ampere's Law.
   d) Gauss law in magneto-statics.

5) Poynting's vector S is _____.
   a) parallel to electric field vector
   b) parallel to magnetic field vector
   c) parallel to propagation vector $\vec{K}$
   d) perpendicular to propagation vector $\vec{K}$

6) Newton's third law does not hold good in _____.
   a) electro-statics b) magneto-statics
   c) electro-dynamics d) all above three

7) The expression for coefficient of reflection (R) is _____.
   a) $\frac{(n_1 - n_2)^2}{(n_1 + n_2)^2}$ b) $\frac{(n_1 + n_2)^2}{4n_1 n_2}$
   c) $\frac{(n_1 - n_2)^4}{4n_1 n_2}$ d) $\frac{(n_1 - n_2)^2}{2n_1 n_2}$

8) The expression for coefficient of transmission (T) is _____.
   a) $\frac{(n_1 - n_2)^2}{(n_1 + n_2)^2}$ b) $\frac{4n_1 n_2}{(n_1 + n_2)^2}$
   c) $\frac{(n_1 - n_2)^4}{4n_1 n_2}$ d) $\frac{(n_1 - n_2)^2}{2n_1 n_2}$

9) In the definition of skin depth, it is distance over which field amplitude reduces to _____.
   a) nearly one fifth b) $\frac{1}{e}$
   c) one half d) one fourth

10) For physical dipole the distance (d) between the charges is related to distance (r) of point of observation _____.
   a) $d \ll r$ b) $d \gg r$
   c) $d \simeq r$ d) $d = r$

11) In case of electric dipole, the radiation zone approximation is expressed as _____.
   a) $r \gg \frac{c}{\omega}$ b) $r \ll \frac{c}{\omega}$
   c) $r \approx \frac{c}{\omega}$ d) $r = \frac{c}{\omega}$

12) The plot of power radiated (P) against acceleration (a) of a charged particle in $(v \ll c)$ limit is _____.
   a) parabola b) ellipse
   c) hyperbola d) straight line

13) The direction of Poynting vector in case of electromagnetic wave propagating in vacuum is _____.
   a) perpendicular to both Electric field and Magnetic field
   b) parallel to both Electric field and Magnetic field
   c) perpendicular to Electric field but not to Magnetic field
   d) perpendicular to Magnetic field but not to Electric field

14) The graph of Intensity of electromagnetic wave against electric field amplitude is _____.
   a) straight line b) parabola
   c) ellipse d) hyperbola

Q.2 A) Answer the following questions (Any Four) **08**

1) Explain in detail Biot and Savart's Law with example.
2) Give significance of Poynting's Theorem.
3) Give single application of Faraday's law in electro-magnetism.
4) Obtain the approximate potential at a point far from dipole.
5) Calculate the total charge on a thin ring of diameter one meter if linear charge density is $p(x) = \alpha x$ where $\alpha = 1.6$. How many electrons are there on the ring?

B) Write short notes (Any Two) **06**

1) Maxwell's equations in dielectric medium
2) Multi-pole expansion of electrostatic potential
3) Dipole moment of continuous charge distribution

Q.3 A) Answer the following questions (Any Two) **08**

1) Derive an expressions for energy stored in electric and magnetic field.
2) Discuss in detail Lorentz and Coulomb gauge.
3) Express the electromagnetic wave equations in D' Almbertian Operator.

B) Answer the following questions (Any One) **06**

1) For $\Phi(x, y, z) = 0.5xyz + 0.7yz + 0.9xy^2$, Calculate electric field $\overrightarrow{E}$ at point P(2,4,6).
2) Calculate the coefficient of Transmission (T) at the interface for pair of media having refractive indices $n_1 = 1.50$ and $n_2 = 1 \cdot 33$

Q.4 A) Answer the following questions (Any Two) **10**

1) Give full account of Maxwell's equations for moving medium.
2) Give Maxwell's correction to fourth equation on the basis of equation of continuity.
3) Explain the concept of Displacement current.

B) Answer the following questions (Any One) **04**

1) Give brief account of magnetic interaction of two current loops.
2) Discuss the case of oblique incidence of electromagnetic wave at boundaries.

Q.5 Answer the following questions (Any Two) **14**

a) Derive an expression for coefficient of Reflection (R) and Transmission (T).
b) Explain in detail the concept of radiation damping.
c) Derive an expression for linear and angular momentum associated with electromagnetic wave.

SLR-JO-298

Seat No.	

Set P

M.Sc. (Semester - II) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
STATISTICAL MECHANICS

Day & Date: Friday, 08-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of non-programmable calculator is allowed.

Q.1 A) Fill in the blanks by choosing correct alternatives given below. **08**

1) The state of a molecule of an ideal gas in a vessel is represented by a point in a phase space of _____.
   a) One dimension b) Two dimensions
   c) Four dimensions d) Six dimensions

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

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

4) The thermal inertia of a thermodynamic system is known as _____.
   a) its enthalpy b) its entropy
   c) its isothermal condition d) its adiabatic condition

5) A quantitative explanation of Brownian motion was given by _____.
   a) Albert Einstein b) Maxwell
   c) Robert Brown d) Boltzmann

6) The condition for thermal equilibrium is given by _____.
   a) $(\partial S_1/\partial U_1) = (\partial S_2/\partial U_1)$ b) $(\partial S_1/\partial N_{i1}) = (\partial S_2/\partial N_{i2})$
   c) $(\partial S_1/\partial T_1) = (\partial S_2/\partial T_1)$ d) $(\partial S_1/\partial V_1) = (\partial S_2/\partial V_1)$

7) The flow of heat from hot body to cold body is an example of _____ process.
   a) adiabatic b) irreversible
   c) reversible d) isothermal

8) The phonon is called as _____.
   a) Fermion b) Boson
   c) Antiparticle d) Boltzman particle

B) State True or False. **06**

1) In viral expansion for gas, the second viral coefficient is zero at the Boyle temperature.
2) The transition in $BaTiO_3$ is an example of second order phase transition.
3) Temperature should change in isothermal process.

4) The chemical potential for ideal bose gas is less than zero.
5) When heat propagates like a wave with a infinite velocity through the liquid helium. This phenomenon is called as second sound.
6) Photon, Phonon etc. obeys Fermi Dirac distribution function.

Q.2 A) Answer the following (Any Four) **08**

1) Calculate the equation of state of ideal Fermi gas and its classical limit.
2) State and derive most probable distribution for a quantum ideal gas.
3) Derive the equation for particle function in Grand Canonical Ensemble.
4) Distinguish between 1^{st} and 2^{nd} order phase transition graphically.
5) Show that during the second order phase transition $(\partial^2 \mathrm{G}_1 / \partial \mathrm{T}^2) \neq (\partial^2 \mathrm{G}_2 / \partial \mathrm{T}^2)$

B) Write Notes on (Any Two) **06**

1) Explain the concept of microstate and macrostates
2) Explain the concept of statistical equilibrium.
3) How will you explain the contact between thermodynamics and statistical mechanics?

Q.3 A) Answer the following (Any two) **08**

1) Show that in Bose-Einstein condensation all the particles accumulate in ground stat.
2) Establish Fokker Pank equation and solve it.
3) What is an energy fluctuation? Explain it in terms of canonical ensemble?

B) Answer the following (Any One) **06**

1) How the paradoxical situation arises when we mix the samples of same gas.
2) Write a note on Critical Indices.

Q.4 A) Answer the following (Any Two) **10**

1) Distinguish between Classical and Quantum statistics.
2) Write note on Fluctuation-Dissipation theorem.
3) Explain the second order phase transition with an example of $\mathrm{BaTiO_3}$.

B) Write Notes on (Any Two) **04**

1) What is an ensemble? Explain the concept of Canonical Ensemble.
2) State Liouville's theorem. What is the principle of conservation of density in it?

Q.5 Answer the following (Any two) **14**

a) What is Brownian motion? Set up the diffusion equation and solve it. Show that $< \mathrm{r}^2(\mathrm{t}) > = 6Dt$, where D is the diffusion coefficient.

b) Derive Ehrenfest equation for second order phase transition.

c) 1 kg of water at temperature $30^0\mathrm{C}$ is mixed with 2 kg of water at $90^0\mathrm{C}$ in a calorime of negligible heat capacity at constant pressure of 1 atm. Find the change in entropy of the system.

Seat No.	

Set **P**

M.Sc. (Semester – III) (CBCS) Examination Oct/Nov-2019
Physics(Materials Science)
SEMICONDUCTOR DEVICES

Day & Date: Monday, 18-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of Non-programmable calculator is allowed.

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) The basic advantage of the CMOS technology is _____.
   a) it is easily implemented
   b) considerable reduction in size
   c) low power consumption
   d) better switching capabilities

2) The V_{GS} (on) of an n- channel E-MOSFET is _____.
   a) Less than the threshold voltage
   b) Equal to the gate - source cut off voltage
   c) Greater than V_{DS}(on)
   d) Greater than-V_{GS} (th)

3) In recent MOSFET's the material used for the gate is _____.
   a) high purity silicon
   b) high purity silica
   c) heavily doped poly crystalline silicon
   d) Epitaxial grown silicon

4) A MOS capacitor made using P type substrate in the accumulation mode. The dominant charge is due to the presence of _____.
   a) Holes
   b) Electrons
   c) Positively charged ions
   d) Negatively charged ions

5) The drain current of a MOSFET in saturation is given by $I_D = K(V_{GS} - V_T)^2$ where K is a constant. The magnitude of the trans-conductance gm is given by _____.
   a) $\frac{K(V_{GS} - V_T T)^2}{V_{DS}}$
   b) $\frac{I_d}{(V_{GS} - V_{DS})}$
   c) $2K(V_{GS} - V_T T)^2$
   d) $\frac{K(V_{GS} - V_T T)^2}{V_{GS}}$

6) The peak inverse current I_p for a power diode is given by the expression _____.
   a) $I_p = t + di/dt$
   b) $I_P = t^* \log I$
   c) $I_p = t^* di/dt$
   d) $I_p = t^* \int t^* i \, dt$

7) A Traic is equivalent to two SCRs _____.
   a) in parallel
   b) in series
   c) in inverse parallel
   d) None of the above

8) Latching current for the GTOs is _____ as compared to conventional thyristors.
   a) more b) less
   c) constant d) none of these

9) The controlling parameter in IGBT is the _____.
   a) I_G b) V_{GE}
   c) I_C d) V_{CE}

10) The number of modes of operation for n type GaAs is: _____.
   a) Two b) Three
   c) Four d) Five

11) The internal quantum efficiency of LEDs decreasing _____ with _____ temperature.
   a) Exponentially, decreasing b) Exponentially, increasing
   c) Linearly, increasing d) Linearly, decreasing

12) _____ has more sophisticated structure than p-i-n photodiode.
   a) Avalanche photodiode b) p-n junction diode
   c) Zener diode d) Varactor diode

13) The detection mechanism in _____ relies on photo excitation of electrons from confined states in conduction band quantum wells.
   a) p-i-n detector b) Quantum-dot photo detector
   c) p-n photodiode d) Avalanche photodiodes

14) _____ is less than or unity for photo detectors.
   a) Absorption coefficient b) Band gap energy
   c) Responsivity d) Quantum efficiency

Q.2 A) Attempt any four of the following question. **08**

1) What are MIS structures? Mention their significance.
2) Give the applications of Light activated thyristors.
3) Define Dark current.
4) Define avalanche effect.
5) List the applications of TR LED.

B) Write short notes. (Any Two) **06**

1) With neat schematic, discuss the construction and working of MIS capacitors.
2) Write a note on CMOS devices.
3) Distinguish between DIAC and TRIAC.

Q.3 A) Attempt any two of the following question. **08**

1) Briefly explain the trapping and flat band voltages.
2) What is a thyristor? List the types.
3) Define Transferred Electron Effect with an example.

B) Write Short notes. (Any One) **06**

1) Silicon Unidirectional Switch (SUS).
2) Emission spectra of LED.

Q.4 A) Attempt any two of the following question. **10**

1) With necessary theory and diagram, discuss the two transistor analogy of SCR. Draw the characteristics.
2) Briefly explain the working of PUT. Mention its applications.
3) Calculate the wavelength of emission from GaAs semiconductor laser whose band gap energy is 1.44 ev (plank's constant is 6.625×10^{-34} Js and charge of an electron is 1.6×10^{-19} C.

B) Attempt any one of the following question. **04**

1) With a neat schematic, describe the working principles of GUNN diode. Draw and explain its I-V characteristics.
2) Explain the charge transfer mechanisms in CCD.
3) Describe the structure, construction and working of LEDs. List its applications.

Q.5 Attempt any two of the following question. **14**

1) Define Quantum efficiency. Describe the detection mechanism in photo detectors. List types of photo detectors and their applications.
2) A double heterojunction InGaAsP LED emitting at a peak wavelength of 1310 nm has radiative and non - radiative recombination times of 30 and 100 ns respectively. The drive current is 40 mA, then find
   i) Bulk recombination lifetime
   ii) Internal quantum efficiency
   iii) Internal power.

3) Discuaibss the working principles of solarcells and draw its I- V characteristics.

SLR-JO-300

Seat No.	

Set P

M.Sc. (Semester – III) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
ATOMIC, MOLECULAR & NUCLEAR PHYSICS

Day & Date: Tuesday, 05-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of Non-programmable calculator is allowed.

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Spherical tops type of molecules have all moment of _____.
   a) $I_A = I_B = I_C$ b) $I_A = I_B \neq I_C$
   c) $I_A \neq I_B = I_C$ d) $I_A = 0, I_B \neq I_C$

2) The Lande g factor single state is for $^5F_2$ state.
   a) 0 b) 2
   c) 1 d) 3

3) The magic number in nuclear physics arises mainly due to _____.
   a) Short character of nuclear force
   b) Dipole-dipole interactions
   c) Coulomb interaction
   d) Spin orbit interaction

4) The Scattering amplitude of n-p interaction is _____.
   a) $F(\theta) = \frac{e^{-i\delta\theta} \sin\delta\theta}{k}$ b) $F(\theta) = \frac{e^{i\delta\theta} \sin\delta\theta}{k}$
   c) $F(\theta) = \frac{e^{-2i\delta\theta} \sin\delta\theta}{k}$ d) $F(\theta) = \frac{\sin\delta\theta}{k}$

5) For an atom in the state of $^2D_{5/2}$ the Lande 'g' factor should be _____.
   a) 1.00 b) 2.20
   c) 1.20 d) 1.02

6) According to the shell model of the nucleus which is incorrect?
   a) Nucleons in a nucleus interact with a general force field
   b) Magic number exists
   c) Nucleons interact with their nearest neighbours only
   d) Large electronic quadruple moment exists for certain nuclei

7) According to the single particle nuclear shell model, the spin parity of the ground state of $^{17}_{8}O$ is _____.
   a) $\frac{1^-}{2}$ b) $\frac{3^-}{2}$
   c) $\frac{5^+}{2}$ d) $\frac{3^+}{2}$

8) The binding energy of deuteron is _____.
   a) 2.226 MeV b) 0.226 MeV
   c) 1.226 MeV d) 3.226 MeV

9) In case of jj Coupling spin s_i* of each electron is quantized with respect to _____ to form a resultant j_i*.
   a) its own l_i* b) another electron's l_i*
   c) its own s_i* d) another electron's s_i*

10) If Q value of nuclear reaction is positive the reaction is _____.
   a) Exothermic b) Endothermic
   c) Endergonic d) None of these

11) Transition rule for the vibrational-rotational spectra are _____.
   a) $\Delta j = \pm 1, \pm 2 \ldots..$ b) $\Delta j = \pm 1$
   c) $\Delta n = \pm 1, \Delta j = \pm 1$ d) None of these

12) The electric quadrupole moment Q is zero for _____ nuclei.
   a) Oblate b) Spherical
   c) Prolate d) None of these

13) In case of LS coupling $l_1=1$ and $l_2=2$, then J= _____.
   a) 1,2,3,4 b) 0,1,2,3
   c) 2,3,4 d) 0,1,2,3,4

14) What is the moment of inertia I_B, of $^{1}H^{79}Br$ if the bond distance is 142 pm? Atomic masses are: ^{1}H = 1.008 u, ^{79}Br = 78.92 u.
   a) 3.33×10^{-47} kg.m^2 b) 3.00×10^{46} kg.m^2
   c) 2.34×10^{-37} kg.m^2 d) 1.22×10^{-7} kg.m^2

Q.2 A) Answer the following questions. (Any Four) **08**

1) How molecules are distinguish based on moment of inertia?
2) Explain the significance of the Q-Value of a nuclear reaction.
3) What is the range of the nuclear force? Why is it so short?
4) What is meant by Q values of nuclear reactions?
5) Define Hund's rule.

B) Write short notes. (Any Two) **06**

1) Calculate Lande g factor for $^{3}S_1$ and $^{3}P_1$ levels.
2) What are assumptions of liquid drop model of the nucleus?
3) Draw and label the vibrational energy levels for a diatomic molecule undergoing anharmonic oscillations.

Q.3 A) Answer the following questions. (Any two) **08**

1) State and explain Pauli's exclusion principle.
2) What is the moment of inertia (IB) of $^{1}H^{79}Br$ if the bond distance is 142 pm? (Given: Atomic masses are: ^{1}H = 1.008 amu, ^{79}Br = 78.92 amu.).
3) Distinguish between symmetric top and asymmetric top molecules.

B) Answer the following questions. (Any One) **06**

1) What is the evidence for shell structure of the nucleus? Explain the shell model of the nucleus.
2) The fundamental vibration frequency of HCl is 2989 cm^{-1}. Find the force constant of HCl bond. (Given: the mass of Hydrogen and Chlorine atoms are 1.673×10^{-27} kg and 58.06×10^{-27} kg respectively).

Q.4 A) Answer the following questions. (Any Two) **10**

1) Distinguish between the energy levels of a rigid and a non rigid rotor.
2) Calculate the magnetic moment and term shift of atom corresponding to the state $^{2}P_{1/2}$.

3) Rotational and centrifugal distortion constant of HCl molecule are 10.593 cm^{-1} and 5.3×10^{-4} cm^{-1} respectively. Estimate the vibrational frequency and force constant of molecule. (Given the mass of Hydrogen and Chlorine atoms are 1.673×10^{-27} kg and 58.06×10^{-27} kg respectively).

B) Answer the following questions. (Any One) **04**

1) What are types of nuclear reactions and discuss the nuclear reaction kinematics?
2) Discuss n-n scattering at high energy.

Q.5 Answer the following questions . (Any two) **14**

a) Why HCl molecule is microwave active and obtains the expression for moment of inertia for diatomic molecule as rigid rotator.

b) How the discrepancies caused in shell model is overcome in collective model?

c) Give the schematic representation of interaction energies between ps electrons in L-S coupling.

SLR-JO-302

Seat No.	

Set P

M.Sc. (Semester - III) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
MATERIALS PROCESSING

Day & Date: Thursday , 07-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Out of the following conditions which will result in a thin film of larger grains?
   a) High deposition rate and low substrate temperature
   b) Low deposition rate and high substrate temperature
   c) High deposition rate and high substrate temperature
   d) Low deposition rate and low substrate temperature

2) Refractory metals such as Tungsten or Tantalum are usually used as filaments in resistive evaporation because of their _____.
   a) Hardness b) Conductivity
   c) Melting point d) Ductility

3) The following cannot be deposited using DC sputtering _____.
   a) Metal b) Oxide
   c) Alloy d) All above

4) In absence of wetting between the deposited material and the substrate which type of thin film growth can be expected?
   a) Both "island" and "layer" are possible
   b) Only "layer" type, no "island"
   c) Only "island" type, no "layer"
   d) No deposition

5) An important requirement for electrodeposition is _____ substrate.
   a) Extremely flat b) Conducting
   c) Rough d) specific shaped

6) Out of the following properties the sticking coefficient depends on ____.
   a) Substrate area b) Substrate temperature
   c) Substrate shape d) None of the above

7) The theory of capillary nucleation considers the _____.
   a) Melting point of the Substrate
   b) Interface energy of the film and substrate
   c) Roughness of the Substrate
   d) All of the above

8) One of the main parameters affecting the nucleation process is _____.
   a) Substrate charge b) Deposition rate
   c) Substrate shape d) Substrate roughness

9) The sputtering yield can be defined as _____.
   a) The number of sputtered atoms per incident particle
   b) The number of sputtered atoms per unit solid angle
   c) The number of sputtered atoms per second
   d) The amount of energy which is dissipated after the collision with target (per particle)

10) One atmospheric pressure equals to.
   a) 1 Torr
   b) 760 Torr
   c) 7.6 Torr
   d) 76 Torr

11) In physisorption the electronic structure of the surface atoms _____due to adsorption of the adsorbate molecules.
   a) Changes irrespective of the adsorbate concentration
   b) Changes with respect to the adsorbate concentration
   c) Does not change irrespective of the adsorbate concentration
   d) None of the above

12) The composition of the deposited thin films ____in sputter-deposition of alloys.
   a) depends on the plasma (gas)
   b) depends on sputtering rate
   c) is same as that of the target composition
   d) is not same as that of the target composition

13) Which of the following property of thin film will remain unchanged even after changing the thin film deposition technique?
   a) Thickness
   b) Purity
   c) Temperature
   d) Uniformity

14) In thermal evaporation the rate of evaporation depends on.
   a) Pressure in the evaporation chamber
   b) Size of the chamber
   c) Shape of the chamber
   d) Distance between the source and substrate

Q.2 A) Answer the following question. (Any Four) **08**

1) Which principle is used to measure thickness of the film by quartz crystal microbalance?
2) Why conductivity of the thin film decreases with decrease in thickness?
3) Write down the forces involved in chemisorption and physisorption.
4) Which vacuum pump is known as rough pump?
5) Why in case of MOCVD we get carbon impurity?
6) Mismatch between which factors cause stress in thin film?

B) Write Notes. (Any Two) **06**

1) Laser ablation
2) Spray pyrolysis
3) Bayet-Alpert guage

Q.3 A) Answer the following questions. (Any Two) **08**

1) What are different pros and cons of CVD over PVD?
2) Explain working of pirani guage, in which vacuum range it can be used?
3) Discuss importance of ALD.

B) Answer the following questions. (Any One) **06**

1) Write the principles of cryogenic pump and titanium sublimation pump.
2) Explain in detail different types of sputtering.

Q.4 A) Answer the following questions. (Any Two) **10**

1) Discuss in brief different types of CVD.
2) Explain grain boundary and thin film diffusion.
3) Explain in detail ion plating.

B) Answer the following questions. (Any One) **04**

1) How stress is generated in thin films?
2) How work function changes by induced adsorbate?

Q.5 Answer the following questions. (Any Two) **14**

a) Discuss different types of physical vapour deposition techniques.
b) Discuss mechanical, electrical and optical properties of thin films.
c) Discuss diffusion in thin film.

SLR-JO-304

Seat No.	

Set P

M.Sc. (Semester - IV) (CBCS) Examination Oct/Nov-2019
Physics (Material Science)
MICROELECTRONICS

Day & Date: Monday, 04-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) In wet etching, material is removed by _____.
   a) absorption
   b) sublimation
   c) chemical reaction
   d) the force exerted due to flow of solvent

2) Repeatable entity of a crystal structure is known as _____.
   a) crystal b) lattice
   c) unit cell d) miller indices

3) To obtain crystal structure while fabricating the integrating circuits the commonly used method is _____.
   a) oxidation b) epitaxial growth
   c) photolithography d) silicon wafer preparations

4) Oxidation process in Silicon planer technology is also called as _____.
   a) photo oxidation b) silicon oxidation
   c) vapor oxidation d) thermal oxidation

5) Photoresist layer is formed using.
   a) high sensitive polymer b) light sensitive polymer
   c) polysilicon d) silicon di oxide

6) Lithography is a process used to _____.
   a) transfer a pattern to a layer on the chip
   b) develop an oxidation layer on the chip
   c) develop a metal layer on the chip
   d) produce the chip

7) Heavily doped polysilicon is deposited using _____.
   a) chemical vapor decomposition b) chemical vapor deposition
   c) chemical deposition d) dry deposition

8) Fick's first law of diffusion is expressed as,
   a) $j = -D * \partial C(x,t)$ b) $j = -\frac{\partial c(x,t)}{\partial x}$
   c) $j = -D\frac{\partial C(x,t)}{\partial x}$ d) $j = -\partial N/\partial x$

9) To suppress unwanted conduction ____ is used.
   a) phosphorus b) boron
   c) silicon d) oxygen

10) The advantage of E-beam mask is _____.
   a) small feature size b) larger feature size
   c) looser layer d) complex design

11) Glassivation is usually done by _____.
   a) Chemical Vapor Deposition b) Chemical Bath Deposition
   c) Electro Chemical Deposition d) Molecular Beam Epitaxy

12) The most commonly used material for the interconnection is _____.
   a) boron b) oxygen
   c) aluminum d) silicon

13) As die size shrinks, the complexity of making the photomasks _____.
   a) increases b) decreases
   c) remains the same d) cannot be determined

14) nMOS devices are formed in _____.
   a) p-type substrate of high doping level
   b) n-type substrate of low doping level
   c) p-type substrate of moderate doping level
   d) n-type substrate of high doping level

Q.2 A) Answer the following questions. (Any Four) **08**
1) List the prominent characteristics of the substrates.
2) Mention the salient features of ion implantation.
3) Define Etch back effect.
4) Give the reasons for the failure mechanisms in interconnects.
5) Mention the types of bonding techniques.

B) Write Notes. (Any Two) **06**
1) Clean room and safety requirements
2) Effects of annealing
3) Photo resists

Q.3 A) Answer the following questions. (Any Two) **08**
1) Distinguish between epitaxy and diffusion.
2) Discuss the salient features of CVD technique.
3) Write a note on thermal oxidation.

B) Write Notes. (Any Two) **06**
1) Mask generation using co-ordination graph.
2) Printed Grid Array and Ball Grid Array.

Q.4 A) Answer the following questions. (Any Two) **10**
1) Compare and contrast VBE and LPE techniques.
2) Explain briefly the mass transport limited and surface reaction limited reactions.
3) Write a note on orientation dependence of oxide growth rate.

B) Answer the following questions. (Any One) **04**
1) Discuss briefly on the optical lithography technique.
2) Write a note on package sealing and encapsulation.

Q.5 Answer the following questions. (Any Two) **14**
a) Discuss Deal and Groves model for kinetics of Si-oxidation.
b) With a neat schematic, explain the magnetron sputtering technique.
c) With relevant diagrams, explain the masking sequence and process flow of n-MOS devices.

SLR-JO-305

Seat No.	

Set P

M.Sc. (Semester - IV) (CBCS) Examination Oct/Nov-2019
Physics(Materials Science)
PHYSICS OF NANO MATERIALS

Day & Date: Wednesday, 06-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

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

Q.1 A) Fill in the blanks by choosing correct alternatives given below. **08**

1) The temperature below red heat, thermionic emission from uncharged bodies is chiefly.
   a) Positive b) Constant
   c) Negative d) All of above

2) The conductivity expression in Arrehenious type thermally activated conduction can be given by the relation.
   a) $\sigma = \sigma_0$ exp (E_a/kT) b) $\sigma = -\sigma_0$ exp (E_a/kT)
   c) $\sigma = \sigma_0$ exp (-E_a/kT) d) All of above

3) If an electron is confined in limited space then the allowed energy states are _____.
   a) continuous b) limited
   c) discrete d) none of the above

4) If the size of the metal nanoparticles decreases then the position of the SPR peak exhibits.
   a) red shift b) blue shift
   c) no shift d) none of the above

5) Similar to the bulk material, boron nitride nanotubes are a band gap _____.
   a) $\sim 4.5\ eV$ b) $\sim 5\ eV$
   c) $\sim 5.5\ eV$ d) None of above

6) The contrast transfer function frequently referred to in _____ imagining.
   a) TEM b) HRTEM
   c) SEM d) FESEM

7) The surface area to volume ratio of a sphere with radius 30 nm is ____.
   a) 10^{10} b) 10^{9}
   c) 10^{8} d) 10^{6}

8) In bottom up approach the building blocks can be.
   a) atoms b) molecules
   c) clusters d) all above

B) State True or False / Fill in the blanks: **06**

1) Core-Shell quantum dots are a class of materials which have properties intermediate between those of small, individual molecules and those of bulk, crystalline semiconductors.
2) AFM use feedback to regulate the current on the sample.
3) The electron mobility in semiconductors can be greatly decreased by the formation of polarons.

4) STM is based on the concept of quantum tunneling.
5) DC sputtering cannot be used for deposition of _____.
6) In SEM the morphology of the sample is achieved with the help of _____.

Q.2 A) Answer the following questions. (Any Four) **08**

1) Define and draw the structure of quantum dots.
2) Define and draw the structure of quantum wires.
3) Define photoluminescence.
4) Molecular machines.
5) Explain in brief buckminsterfullerene.

B) Write Notes. (Any Two) **06**

1) Thermionic electron gun
2) BN Nanotubes
3) Explain in brief the basic process of VLS technique

Q.3 A) Answer the following questions. (Any two) **08**

1) Write a note on polaron conduction mechanism.
2) Write a note on Quantum confinement.
3) Write a note on Surface Plasmon resonance (SPR).

B) Answer the following questions. (Any One) **06**

1) Draw density of states at low dimensional structure.
2) Describe the basic working principle of TEM.

Q.4 A) Answer the following questions. (Any Two) **10**

1) Explain Molecular Beam Epitaxy.
2) Explain synthesis of SnO_2 nanoparticles using Sol – Gel Method.
3) Explain the basic difference between a PVD and CVD process.

B) Answer the following questions. (Any One) **04**

1) Write a note on assumptions made in Free Electron model.
2) Write a note on electrodeposition.

Q.5 Answer the following questions. (Any two) **14**

a) Derive the AC electrical conductivity of a metal according to Drude model. Explain the inadequacies of Drude model.

b) Bottom-up technique is more convenient for nano fabrication – Explain.

c) What is carbon nanotubes? Explain SWCNT.

SLR-JO-306

Seat No.	

Set P

M.Sc. (Semester – IV) (CBCS) Examination Oct/Nov-2019
Physics (Material Science)
MAGNETIC MATERIALS

Day & Date: Friday, 08-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) In SI units, tesla is expressed as _____.
   a) kg/m^2s^2A b) kg/s^2A
   c) $NA^{-1}m^{-3}$ d) None of these

2) Diamagnetic materials possess _____.
   a) Permanent magnetic dipoles b) None of these
   c) Induced dipole moment d) no permanent magnetic dipoles

3) The magnetic susceptibility χ of a paramagnetic material change with absolute temperature as _____.
   a) $\chi \propto T^{-1}$ b) $\chi \propto T$
   c) $\chi = constant$ d) $\chi \propto e^T$

4) The temperature below which certain material are anti-ferromagnetic and above which they are paramagnetic, is called _____.
   a) Neel temperature b) Curie temperature
   c) Weiss temperature d) Kelvin temperature

5) The orbital angular magnetization of an electron in _____.
   a) $\mu_a = \frac{lh}{\pi}$ b) $\mu_a = \frac{lh}{4\pi}$
   c) $\mu_a = \frac{lh}{2\pi}$ d) $\mu_a = \frac{lh}{8\pi}$

6) The typical value for the exchange energy between two neighboring moments in a ferromagnetic crystal is _____.
   a) $0.01\ eV$ b) $0.1\ eV$
   c) $0.5\ eV$ d) $1\ eV$

7) The magnetization (M) of a solid, magnetic induction B and field strength H are related by _____.
   a) $M = (B/\mu_0) - H$ b) $M = 1 + B/H$
   c) $M = 1 - B/H$ d) $M = B - \mu_0 H$

8) If T_N is the Neel temperature for an antiferromagnet, its susceptibility is given by _____.
   a) $\chi = \frac{C}{T - T_N}$ b) $\chi = \frac{C}{T + T_N}$
   c) $\chi = \frac{C}{T_N - T}$ d) $\chi = \frac{C}{2T + T_N}$

9) Magnetic Susceptibility (χ) = - 1 for a _____.
   a) Metal b) Semiconductor
   c) Insulator d) Superconductor

10) In nickel-zinc ferrite with Zn/Ni atom ratio equal to 3/5, the number of unpaired electron spins present per $Ni_{0.625}^{2+}\ Zn_{0.375}^{2+}Fe_2^{3+}O_4^{2-}$ is (assume that zinc ions push the ferric ions from tetrahedral sites to octahedral sites and changes their spins).
a) 5 b) 3.75
c) 1.25 d) 4.5

11) Exchange interaction between any two electrons is _____.
a) $E_{ex} = +2J_{ex}S_iS_j$ b) $E_{ex} = +4J_{ex}S_iS_j$
c) $E_{ex} = -2J_{ex}S_iS_j$ d) $E_{ex} = -4J_{ex}S_iS_j$

12) Curie law $\chi = C/T$ is valid for _____.
a) Diamagnet b) Paramagnet
c) Ferromagnet d) All substances

13) At Neel temperature _____.
a) susceptibility is maximum
b) susceptibility is minimum but not zero
c) susceptibility is zero
d) none of these

14) The phenomenon in which a change in the shape of certain ferromagnetic material is produced when they are subjected a magnetic field, in known as _____.
a) Electrostriction b) Magnetostriction
c) Piezoelectric effect d) Anisotropic effect

Q.2 A) Answer the following questions. (Any Four) **08**
1) Explain the Flux meter.
2) Discuss Uniaxial Crystals.
3) Comment on the Susceptibility Measurements.
4) Discuss Domain Wall Motion.
5) Explain y - Fe_2O_3.

B) Write short notes (Any Two) **06**
1) Antiferromagnetic Alloys.
2) Magnetic Moments of Atoms.
3) Vibrating - Sample Magnetometer.

Q.3 A) Answer the following questions. (Any Two) **08**
1) Applications of magnetostriction.
2) Explain Polycrystalline materials.
3) Discuss Theories of Ferromagnetism.

B) Answer the following questions. (Any One) **06**
1) Discuss the concept of exchange forces.
2) Explain ΔE Effect.

Q.4 A) Answer the following questions. (Any Two) **10**
1) Write a note on Magnetostatic Energy and Domain Structure.
2) Discuss the Magnetic measurements in closed circuits.
3) Write a note on Spinel Ferrites.

B) Answer the following questions. (Any One) **04**
1) Discuss Effect of Stress on Magnetostriction.
2) Write a note on Magnetization in Low Fields.

Q.5 Answer the following questions. (Any Two) **14**

a) Define magnetostriction and discuss the physical origin of magnetostriction.

b) Explain in detail the quantum theory of paramagnetism.

c) Give an account for molecular field theory of ferromagnetism.

SLR-JO-307

Seat No.	

Set P

M.Sc. (Semester - IV) (CBCS) Examination Oct/Nov-2019
Physics (Materials Science)
ADVANCED TECHNIQUES OF MATERIALS CHARACTERIZATION

Day & Date: Monday, 11-11-2019 Max. Marks: 70
Time: 03:00 PM To 05:30 PM

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

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Which of the following are considered to be the lowest form of Electromagnetic radiation?
   a) IR radiation b) Micro waves
   c) UV radiation d) Radio waves

2) _____ are true for electron microscopy.
   a) specimen should be thin and dry
   b) image is obtained on a phosphorescent screen
   c) electron beam must pass through evacuated chamber
   d) specimen should be thin and dry, image is obtained on a phosphorescent screen and electron beam must pass through evacuated chamber

3) To record X-ray photoelectron spectra of a given material, typical pressure required in a vacuum chamber is _____.
   a) 10^{-3} Torr b) 10^{-4} Torr
   c) 10^{-6} Torr d) 10^{-10} Torr

4) Vibrational transition of molecule is related to _____.
   a) FTIR b) UV -vis Spectroscopy
   c) XRD d) NMR

5) Energy of the electromagnetic radiation is decreases with _____.
   a) Increasing wavelength b) Decreasing wavelength
   c) Both a) and b) d) None of the above

6) TEM images have much higher resolution than images from light Microscopes because _____.
   a) TEM is much greater in size than light microscope
   b) Electrons traveling as waves have wavelengths much shorter than visible light
   c) TEM can achieve greater magnification
   d) The fluorescent screen of TEM can generate high resolution images

7) In Electron microscope, light source is replaced by a beam of very fast moving _____.
   a) Electron b) Neutron
   c) Proton d) Photon

8) _____ types of waves has the shortest wavelength?
   a) Radio waves b) X-ray
   c) Microwave d) UV

9) _____ statement is true.
   a) Gamma rays have longer wavelengths than UV rays
   b) X-rays have longer wavelengths that microwaves
   c) Radio waves have shorter wavelengths than X-rays
   d) Gamma rays have shorter wavelengths than microwaves

10) Metal can transmit these _____.
   a) Radio wave b) Visible light
   c) Microwave d) X ray

11) _____ is the capacity to distinguish between two adjacent points.
   a) Magnification b) Resolving power
   c) lonization d) Emulsification

12) Elastic scattering is take place in _____.
   a) Raman Scattering b) Rayleigh's scattering
   c) Both a) and b) d) None of the above

13) When scanning tunneling microscopy (STM) reveals periodic structures with atomic dimensions, what is exactly seen?
   a) The crystal lattice
   b) Electronic density of states modulations associated to the atomic lattice
   c) Fermi level modulations associated to the atomic lattice
   d) The electron diffraction pattern associated to the atomic lattice.

14) NMR is the study of absorption of _____ by nuclei in a magnetic field?
   a) Radioactive radiation b) IR radiation
   c) Radio frequency radiation d) Microwaves

Q.2 A) Attempt any four of the following questions. **08**
1) Define Poisson Ratio.
2) What is Magic Angle Spinning (MAS)?
3) Difference between optical microscopy and electron microscopy.
4) Define quantum yield.
5) What is IR and Raman active substances?

B) Write Notes. (Any Two) **06**
1) Short note on Raman scattering
2) Explain Fluorescence microscope
3) Describe STM with diagram

Q.3 A) Attempt any two of the following questions. **08**
1) Give an account of Electrostatic and Magnetic focusing in electron microscope.
2) Explain principle and working of NMR Spectroscopy.
3) Deduce an EDAX technique.

B) Attempt any one of the following questions. **06**
1) Discuss classical and quantum approach used to understand Raman Spectroscopy.
2) Explain in detail difference between SEM and TEM.

Q.4 A) Attempt any two of the following questions. **10**
1) Mention the methods used for vibration oscillation in STM. Explain one of them.
2) Which technique is used for surface area measurement explain in detail.
3) Explain Electron energy analyzer of XPS.

B) Attempt any one of the following questions. **04**

1) Write a short note on Auger Transitions
2) Explain acoustic and optical phonon modes.

Q.5 Attempt any two of the following questions. **14**

a) Explain principle, instrumentation and working of TEM with neat labeled diagram.

b) Explain the process of image formation in Scanning Tunneling Microscopy (STM). Also explain different parts and their working in detail.

c) Draw and Explain X-ray photoelectron spectroscopy.