SLR-UN-470

Seat No.	

Set P

M.Sc. (Semester - I) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MATHEMATICAL TECHNIQUES

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

Q.1 A) Select correct alternatives: **06**

1) Consider a counterclockwise circular contour $|z| = 1$ about the origin. The integral $\oint f(z)dz$ over this contour is _____.
   a) $-i\pi$ b) zero
   c) $i\pi$ d) $2i\pi$

2) Two matrices A and B are said to be similar if $B = P^{-1}AP$ for some invertible matrix P. Which of the following statements is Not TRUE?
   a) Det A = Det B
   b) Trace of A = Trace of B
   c) A and B have the same eigenvectors
   d) A and B have the same eigenvalues

3) The solutions to the differential equation $\frac{dy}{dx} = -\frac{x}{y+1}$ are a family of ___.
   a) circles with different radii
   b) circles with different centres
   c) straight lines with different slopes
   d) straight lines with different intercepts on the y-axis

4) A periodic function $f(x)$ of period 2π is defined in $[-\pi, \pi]$ as $f(x) = \begin{cases} -1, -\pi < x < 0 \\ +1, 0 < x < \pi \end{cases}$. The appropriate Fourier series expansion for $f(x)$ is _____.
   a) $f(x) = (4/\pi)[\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \cdots]$
   b) $f(x) = (4/\pi)\left[\sin x - \frac{\sin 3x}{3} + \frac{\sin 5x}{5} - \cdots\right]$
   c) $f(x) = (4/\pi)[\cos x + \frac{\cos 3x}{3} + \frac{\cos 5x}{5} + \cdots]$
   d) $f(x) = (4/\pi)[\cos x - \frac{\cos 3x}{3} + \frac{\cos 5x}{5} - \cdots]$

5) The Fourier transform of the derivative of the Dirac δ-function, namely $\delta'(x)$, is proportional to _____.
   a) 0 b) 1
   c) Sink d) ik

6) The inverse Laplace transform of $f(s) = \frac{1}{s^2(s+1)}$ is _____
   a) $\frac{1}{2}t^2e^{-t}$ b) $\frac{1}{2}t^2 + 1 - e^{-t}$
   c) $t - 1 + e^{-t}$ d) $\frac{1}{2}t^2(1 - e^{-t})$

B) State True or False **08**

1) The operator, $\frac{\mathrm{d}^2}{\mathrm{dx}^2}$ is not Hermitian.
2) The eigenvalues of the matrix $\begin{pmatrix}0 & 1 & 0\\ 1 & 0 & 1\\ 0 & 1 & 0\end{pmatrix}$ are 0, 1, 1.
3) The $(z)^2$ is an analytic function of z everywhere in the complex plane.
4) The value of $(-i)^{(-i)}$ is $e^{\pi/2}$
5) A "periodic function" is given by a function which has a period T = π.
6) A Laplace transform exists when the function is of differential order.
7) The solution of the differential equation $\frac{dx}{dt} - x^2 = 0$ with initial condition $x(0) = 1$ will blow up as t tends to infinity.
8) A periodic function $f(x)$ of period 2π is not defined in the interval $[-\pi, \pi]$.

Q.2 Short answer type questions:

a) State and explain Cauchy-Riemann conditions. **05**

b) Find the inverse of the matrix, $A = \begin{pmatrix}1 & 3 & 3\\ 1 & 4 & 3\\ 1 & 3 & 4\end{pmatrix}$ **05**

c) Obtain the independent solutions of the differential equation, **04**

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$$

Q.3 **a)** Use residues and evaluate the definite integral, $\int_{-\pi}^{\pi} \frac{\mathrm{d}\theta}{1+\sin^2\theta}$ **08**

b) Find the eigenvalues and eigenvectors of $\mathrm{H} = \begin{pmatrix}0 & 0 & 1\\ 0 & 1 & 0\\ 1 & 0 & 0\end{pmatrix}$ **06**

Q.4 **a)** Using Fourier series in $[-\pi, \pi]$, analyze the square wave in terms of it's Fourier components. **08**

b) Fourier series which will represents $\mathrm{f}(\mathrm{x}) = x \sin x$ in the interval $[-\pi, \pi]$ then prove that, $\frac{\pi}{4} = \frac{1}{2} + \frac{1}{3} - \frac{1}{15} + \frac{1}{35} - \cdots$ **06**

Q.5 **a)** Using the Fourier transform, solve the one-dimensional equation for transverse wave as $\frac{\partial^2\varphi(x,t)}{\partial x^2} - \frac{1}{\vartheta^2}\frac{\partial^2\varphi(x,t)}{\partial t^2} = 0$ **08**

With conditions $\varphi(x,t) \to 0 \; and \; \frac{\partial\varphi}{\partial x} \to 0$ (as $x \to \pm\infty$)

$$\varphi(x,0) = F(x) \text{ and } \frac{\partial\varphi}{\partial t}\Big|_{t=0}^{=0}$$

b) Find the Fourier transform for the box function $\mathrm{f}(\mathrm{x})$ where $f(x) = \begin{cases}1, & (-a \le x \le a)\\ 0 & (|x| > a)\end{cases}$ sketch $\mathrm{f}(\mathrm{x})$ and it's Fourier transform. **06**

Q.6 **a)** Solve $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = x.\sin x$ **08**

b) Let $X_1(t)$ and $X_2(t)$ be two linearly independent solutions of the differential equation, $\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + f(t)x = 0$ and **06**

$let\ W(t) = x_1(t)\frac{dx_2(t)}{dt} - x_2(t)\frac{dx_1(t)}{dt}.\ if\ W(0) = 1$ then find W(1)

Q.7 **a)** Evaluate $\int \frac{(z-1)}{c\,(z+1)^2\,(z-2)} dz$, where C is $|z - i| = 2$ **08**

b) Using Laplace transform, show that $\int_0^{\infty} \frac{\sin \mathrm{tx}}{\mathrm{x}} \mathrm{dx} = \frac{\Pi}{2}$ $(\mathrm{t} > 0)$ **06**

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Seat No.	

Set P

M.Sc. (Semester - I) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
CONDENSED MATTER PHYSICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Attempt five questions.
2) Q.1 and Q.2 are compulsory.
3) Attempt any three questions from Q. 3 to 7.
4) Figures to the right indicate full marks.
5) Use of non scientific calculator is allowed.

Q.1 A) Objectives questions: **06**

1) Miller indices of crystal plane which intercepts at (2a, 3b, c) are _____.
   a) (3, 3, 6) b) (1, 2, 3)
   c) (2, 1, 6) d) (3, 2, 6)

2) Bloch function is _____
   a) $\varphi_r(k) = u_r(k)\exp(ik.r)$ b) $\varphi_k(r) = u_r(k)\exp(ik)$
   c) $\varphi_k(r) = u_k(r)\exp(ik.r)$ d) $\varphi_k(r) = u_k(r)\exp(ik)$

3) p-type semiconductor is formed by adding _____ impurity.
   a) Bivalent b) Trivalent
   c) Tetravalent d) Pentavalent

4) Induced electric dipole moment is directly proportional to _____.
   a) E b) E^2
   c) E^3 d) $E^{1/2}$

5) Superconductor is _____ below critical temperature.
   a) Diamagnetic b) Paramagnetic
   c) Ferromagnetic d) Antiferromagnetic

6) Coordination number of body centred cubic crystal structure is _____.
   a) 6 b) 8
   c) 10 d) 12

B) State true or false. **08**

1) Complex dielectric constant of non-polar solids does not depend on the complex polarisabilities. (True/False)
2) Superconductor has some flux density in presence of applied magnetic field.
3) Diamond is a conductor.
4) Crystalline solids are anisotropic.
5) A superconducting material has a critical temperature of 7.26 K at zero magnetic field and a critical field of 8×10^5 A/m at 0K. Then critical field at 5K is 4.2×10^5 A/m.
6) Relation between electronic polarisability and induced electric dipole moment is given by $\boldsymbol{\mu_{e=}\alpha_e \cdot E}$.
7) Induced electric dipole moment is inversely proportional to electric field E.
8) NaCl shows orientation polarization.

Q.2	**Write short notes:**		**14**
	a)	Explain Type I and II superconductors.	**05**
	b)	Define Dielectric polarization. Give an expression for electronic polarizability.	**05**
	c)	Define 1) Cooper pair 2) Critical temperature 3) Critical current 4) Type I and II superconductor	**04**
Q.3	**a)**	Define penetration depth. Give a relation between penetration depth and temperature.	**08**
	b)	Explain the concept of Brillouin zones.	**06**
Q.4	**a)**	Explain the extended, reduced and periodic zone schemes. Plot energy (E) as a function of wave vector (k) for one dimensional lattice in above three zone schemes.	**08**
	b)	Explain electronic, ionic and orientational polarisabilities.	**06**
Q.5	**a)**	What is meant by imperfections in crystals? Explain the various defects in the crystal.	**08**
	b)	Discuss the Meissner effect in detail.	**06**
Q.6	**a)**	Obtain a solution of wave function of an electron in periodic potential.	**08**
	b)	Explain the extended, reduced and periodic zone schemes.	**06**
Q.7	**a)**	Discuss the BCS theory in details.	**08**
	b)	Differentiate between polycrystalline, nanocrystalline and amorphous materials.	**06**

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Seat No.	

Set P

M.Sc. (Semester - I) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ANALOG & DIGITAL ELECTRONICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) Figures to the right indicate full marks.

Q.1 A) Select the correct alternative: **08**

1) In 8085, memory read cycle is _____ stated.
   a) 3 b) 4
   c) 5 d) 6

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

3) IC 741 Opamp has slew rate of _____ m $V/°C$.
   a) 0.6 b) 0.5
   c) 0.3 d) 0.4

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

5) The _____ gate has two or more input signals but only one output signals.
   a) OR b) AND
   c) XOR d) XNOR

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

7) In microprocessors symbolic address is recorded in the _____ field.
   a) Label b) Opcode
   c) Operand d) Comment

8) In 8085, _____ signal is used to demultiplex address/ data bus.
   a) RD b) WR
   c) ALE d) INTR

B) Fill in the blanks / State true or false:- **06**

1) In JK flip flop race around condition arises due to _____.
2) The sawtooth waveform has a rise time many times than the fall time
3) _____ feedback is used in oscillator circuits.
4) In the oscillator circuit the total phase shift of the loop gain must be _____.
5) A demultiplexer is used to perform _____ conversion.
6) An ideal operational amplifier has zero output impedance.

Q.2 Attempt following:- **14**

a) Addressing modes of 8085 microprocessor
b) Op Amp as an Integrator
c) Adjustable voltage regulators

Q.3 **a)** Explain non inverting configuration of 3 input Op Amp as a summing, scaling and averaging amplifier. **08**

b) Explain effect of negative feedback on output resistance of Op Amp. **06**

Q.4 **a)** What is Oscillator? Describe phase shift oscillator, obtain an expression for frequency of oscillation. **08**

b) Design a phase shift oscillator for f_0 = 1 KHz, using IC741. **06**
(Supply Voltage = $\pm$15V)

Q.5 **a)** Draw and explain function block diagram of Intel 8085 microprocessor. **08**

b) Explain demultiplexing of AD0- AD7 signals. **06**

Q.6 **a)** What is shift register? Draw and explain logic diagram of PIPO shift register. **08**

b) Draw and explain 16:1 multiplexer using AND gate. **06**

Q.7 **a)** Write an ALP for addition of two 8 bit numbers using Direct addressing mode. **08**

b) Reduce the following logical expressions using Boolean laws: **06**
$\bar{A}BC + AB\bar{C} + ABC + \bar{A}B$
Draw logic diagram of reduced expression

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Seat No.	

Set P

M.Sc. (Semester - I) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
CLASSICAL MECHANICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Attempt in all five questions.
2) Q.1 and Q.2 are compulsory.
3) Attempt any three questions from Q. 3 to 7.
4) Figures to the right indicate full marks.

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

1) The Lagrangian of the system gives _____ of the system.
   a) difference in kinetic and potential energy
   b) addition of kinetic and potential energy
   c) power
   d) rate of change of energy

2) Which of the following physical quantity is conserved if total external torque acting on system of particles is zero?
   a) Linear momentum b) Angular momentum
   c) Kinetic energy d) Potential energy

3) Atwood's machine is example of _____ constraint.
   a) holonomic and scaleronomous
   b) non-holonomic
   c) non-holonomic and rheonomous
   d) rhenomous

4) According to Hamiloton's principle, the action integral for monogenic, conservative system should produce _____ value.
   a) unit b) zero
   c) maximum d) extremum

5) In Euler-Lagrange's equation the term, $\left(\frac{\partial L}{\partial q}\right)$ dimensionally represents.
   a) generalized force b) generalized momentum
   c) energy d) nothing

6) In central force problem, conservation of both _____ and _____ takes place.
   a) energy, angular momentum b) energy, torque
   c) angular momentum, torque d) linear momentum, force

7) In central force motion, the differential equation for orbit gives absurd result for $l =$ _____.
   a) 0 b) 1
   c) 2 d) 3

8) Newton's laws of motion to be valid in non-inertial frame, one requires _____.
   a) psudo force b) real force
   c) central force d) conservative force

B) State whether the following statement is True or False: **06**

1) Lagrange's approach cannot be treated as an alternative to Newtonian approach.
2) In case of conservative force, work done between two points is dependent on the path taken between those two points.
3) For "actual path" action integral gives extremum value that is maximum value.
4) Generalized co-ordinates need not be necessarily orthogonal curvilinear co-ordinates.
5) Form of the Hamilton's equations of motion remains invariant under canonical transformation.
6) In canonical transformation, new set of co-ordinates are cyclic.

Q.2 Write a short note on:

a) Conservation laws in central force motion **05**
b) Principle of least action **05**
c) Any two conservation laws for system of particles **04**

Q.3 Attempt the following questions:

a) Starting with D 'Almbert's principle, derive Euler-Lagrange's equation. **08**
b) Set up an equation of motion for Atwood's machine using Euler-Lagrange's equation. **06**

Q.4 Attempt the following questions:

a) Starting from Hamilton's principle, obtain Euler-Lagrange equation. **08**
b) Set up Hamiltonian for simple pendulum and derive equation of motion for it using the same Hamiltonian. **06**

Q.5 Attempt the following questions:

a) Discuss in detail four standard forms of canonical transformations. **08**
b) Show that the transformation $P = \frac{p^2+q^2}{2}, Q = tan^{-1}\left(\frac{q}{p}\right)$ is canonical. **06**

Q.6 Write a short note on:

a) In case of central force motion set up differential equation for orbit and hence deduce law of conservation of angular momentum for it **08**
b) In central force motion, discuss the motion under different cases of force constant (k) in inverse square law. **06**

Q.7 Write a short note on:

a) Derive Hamilton's canonical equation of motion in terms of Poisson bracket. **08**
b) Define Poisson bracket and give its any four important properties. **06**

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Seat No.	

Set P

M.Sc. (Semester - II) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
QUANTUM MECHANICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) Use of Non programmable calculator is allowed.
4) All questions carry equal marks.

Q.1 A) Choose the correct alternative: **06**

1) Heisenberg's uncertainty principle states _____
   a) A particles position can be measured exactly
   b) A particle's energy can be measured exactly
   c) The more precise a particle's momentum can be measured, the less precise its position can be measured
   d) The more precise a particle's momentum can be measured, the less precise its energy can be measured

2) The wave function for a particle must be normalizable because.
   a) The particle's charge must be conserved
   b) The particle's momentum must be conserved
   c) The particle must be somewhere
   d) The particle's angular momentum must be conserved

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

4) According to Schrödinger, a particle is equivalent to a _____.
   a) Single wave b) Wave packet
   c) Light wave d) Cannot behave as wave

5) The energies of a particle in a box are given by _____.
   a) Continuous energy spectrum b) $\frac{n^2 \pi^2 \hbar^2}{2mL^2}$
   c) $\frac{\pi^2 \hbar^2}{2mL^2 n^2}$ d) $\frac{n\hbar}{2\pi}$

6) The wave function in the ground state of hydrogen atom is given as $\Psi = A \exp\ (^{-r}/_{a})$, where r measures distance from nucleus and a is constant. The value of A is _____
   a) $\frac{1}{\sqrt{\pi a}}$ b) $\frac{1}{\sqrt{\pi a^3}}$
   c) $\frac{1}{\sqrt{\pi.a}}$ d) $\frac{1}{\sqrt{\pi a^5}}$

B) State True or False **08**

1) Bound states Ψ must vanish at infinity.
2) The time development of a wave function is $i\hbar \frac{\partial \Psi}{\partial t} = \hat{H}\Psi$.
3) The eigenfunctions belonging to different eigenvalues of a unitary operator are mutually orthogonal.
4) In a non-linear molecule where electronic degeneracy occurs there always exists a vibrational mode which can remove the degeneracy
5) The combined space and spin function of an electron is called a spin-orbital.
6) The wave functions for different states of a harmonic oscillator are mutually orthonormal.
7) For many electron atoms, the electron repulsion terms must be excluded in the potential energy term of the wave equation.
8) The Born-Oppenheimer approximation is not valid as long as the various energy levels in a molecule are widely separated from each other.

Q.2 Write a short note on:

a) Shape of atomic orbitals **05**

b) Characteristics of the wave functions **04**

c) Show that the operators L_Z commustes with L^2. **05**

Q.3 a) Consider a symmetric "1-D rigid box" of length = 2a, **08**

$$V(x) = \begin{cases} = 0 & |x| \leq a \\ \to \infty \; x < -a; \; x > +a \end{cases}$$

Obtain the energy eigenvalues and eigenfunctions.

b) Normalize the energy eigen functions for a particle in a symmetric 1-D finite box (only odd parity) **06**

Q.4 a) Obtain the total wave function of a rigid rotator in the form

$$\Psi(\theta, \emptyset) = \text{Ⓗ}_{\ell,\pm m}(\theta)\, \emptyset_{\pm m}(\emptyset) = \gamma_{\ell,\pm m}(\theta, \emptyset)$$ **08**

b) Calculate the spherical harmonics: (a) $\gamma_{0,0}(\theta, \emptyset)$; (b) $\gamma_{1,\pm 1}(\theta, \emptyset)$ **06**

Q.5 a) Show that how the Hartree and Hartree – Fock self-consistent field methods are powerful for obtaining the ground state energy and wave functions of many-electron atoms. **10**

b) Write down the 1s orbital of the hydrogen atom and obtain the probability density $|\Psi_{1s}|^2$ **04**

Q.6 a) What is the Born-Oppenheimer approximation? Write and interpret each term of the wave equation for it. **08**

b) How the linear combination of atomic orbitals (LCAO) is the basis for the calculation of approximate energies and molecular orbitals in molecules? Explain. **06**

Q.7 a) Explain the fourth postulate of quantum mechanics. **08**

b) Prove that, if two operators $\hat{A}$ and $\hat{B}$ commute then they have the same set of eigenfunctions. **06**

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Seat No.	

Set P

M.Sc. (Semester - II) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ELECTRODYNAMICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.
4) Use of Non programmable calculator is allowed.

Q.1 A) Select correct alternatives: **06**

1) Electric field intensity $(\vec{E})$ at any point in an electric field is equal to _____.
   a) Potential gradient
   b) (Potential gradient)^2
   c) (potential gradient)^{y2}
   d) None of the above

2) The unit of electric flux density is _____
   a) Coulomb
   b) Farad / meter
   c) Coulomb / (meter)^2
   d) Weber / (meter)^2

3) In electromagnetic wave, the phase difference between electric and magnetic field vectors $\vec{E}$ and $\vec{B}$ is _____.
   a) 0
   b) $\frac{\pi}{2}$
   c) π
   d) $\frac{\pi}{4}$

4) Magnetic vector potential due to magnetic dipole is proportional to ___.
   a) r
   b) $\frac{1}{r}$
   c) $\frac{1}{r^2}$
   d) $\frac{1}{r^3}$

5) Larmor formula for the power radiated by a non-relativistically accelerated charged particle is given by _____.
   a) $\frac{1}{4\pi\varepsilon_0}\left(\frac{2}{3}\right)\frac{e^2a^2}{c^3}$
   b) $\left(\frac{2}{3}\right)\frac{e^2a^2}{c^3}$
   c) $\frac{1}{4\pi\varepsilon_0}\left(\frac{2}{3}\right)\frac{e^2a}{c^2}$
   d) $\frac{1}{4\pi\varepsilon_0}\left(\frac{2}{3}\right)\frac{e^2a^2}{c^2}$

6) When angle of incidence is greater than Brewster's angle, the reflected ray suffers a phase change of _____.
   a) π
   b) $\frac{\pi}{2}$
   c) 0
   d) 2π

B) State True or False **08**

1) A monochromatic electromagnetic waves that the field strength at a point varies with time according to sine or cosine function.
2) A free electron (placed in the path of a plane electromagnetic wave) will start moving along the magnetic field.
3) For good conductors, skin depth varies inversely with half power of frequency.
4) A plane-polarized monochromatic electromagnetic wave incident on a plane interface at the Brewster angle gives rise to a unpolarized reflected wave.

5) The direction of propagation of electromagnetic wave is $\vec{E}.\vec{B}$.
6) For the case of a particle moving under attractive central force field, the angular momentum is no more constant but changes due to radiation reaction.
7) The equation of continuity is $\nabla.\bar{J} - \frac{\partial \rho}{\partial t} = 0$
8) In isotropic non-conducting media, the speed of electromagnetic wave is less than that of free space.

Q.2 Answer the following: **14**

a) State the boundary conditions for an electrostatic field $\bar{E}$. **05**

b) How the Maxwell corrected Ampere's law? What is the physical significance of displacement current? **05**

c) A long wire carries a current of uniform density. If i be the total current carried by the wire show that the magnetic energy per unit length stored within the wire is $\frac{\mu_0 i^2}{32\pi}$. **04**

Q.3 **a)** Obtain the expression for magnetic vector potential $\vec{A}(\vec{r})$ in terms of a volume current $\vec{J_b} = \vec{\nabla} \times \vec{M}$ and a surface current $\vec{K_b} = \vec{M} \times \hat{n}$. **10**

b) Find the magnetic field of a uniformly magnetized sphere. **04**

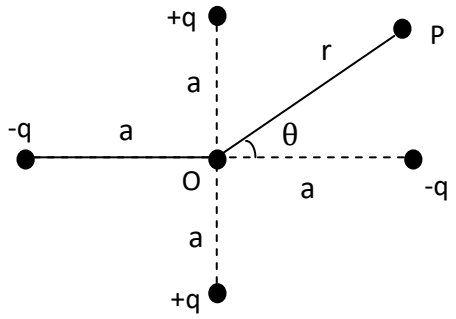
Q.4 **a)** Discuss the "Reflection and Transmission at oblique Incidence" and obtain the Fresnel's equations for the case of polarization in the plane of incidence. **10**

b) What are the phenomena of "Total Internal Reflection"? **04**

Q.5 **a)** What is Thomson scattering? Show that this scattering is independent of the frequency and wavelength of incident beam. **10**

b) If the incident radiation is plane polarized then find the total scattering cross section (L_T). What is the dimension of L_T? **04**

Q.6 **a)** Four charges are arranged as shown in the adjacent Figure. Calculate the monopole moment, dipole moment and quadrupole moment of the system. Hence calculate the electric field $\vec{E}$ at point 'P' located at a distance 'r' from the center of configuration. **10**



b) If at a point on boundary between two dielectric, the electric field make angles θ_1 and θ_2 with the normal in media of permittivity ϵ_1 and ϵ_2 respectively then show that $\frac{\tan\theta_1}{\tan\theta_2} = \frac{\epsilon_1}{\epsilon_2}$. **04**

Q.7 **a)** What are the Gauge transformations? Explain the (a) Coulomb Gauge and (b) Lorentz Gauge. **10**

b) What are the Faraday's law of electromagnetic induction and Lenz's law? **04**

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Seat No.		Set	P

M.Sc. (Semester - II) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ANALYTICAL TECHNIQUES

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any 3 questions from Q. 3 to 7
3) All questions carry equal marks.

Q.1 A) Select Correct alternatives: **06**

1) For hexagonal crystal system $\beta =$ _____
   a) 90 b) 60
   c) 120 d) 80

2) For rhombohedral crystal system γ _____.
   a) $\neq 120$ b) $= 90$
   c) $= 120$ d) $\neq 90$

3) The _____ has a 2-fold axis of rotoinversion.
   a) Hexagonal b) Cubic
   c) Orthorhombic d) Rhombohedral

4) Addition of bravais lattice and basis is called _____.
   a) Grain b) Molecule
   c) Atom d) Crystal

5) FT-IR uses a _____ laser as an internal wavelength standard.
   a) He-Ne b) YAG
   c) He-Hg d) Ne-Hg

6) In XPS the K.E of electron is dependent on _____
   a) Φ of sample b) Φ of spectrometer
   c) Vacuum level of sample d) Vacuum level of spectrometer

B) Fill in gaps. **04**

1) For monoclinic crystal system $\alpha =$_____.
2) For fcc system the number of atoms per unit are _____
3) In XPS, photoelectrons are produced using _____.
4) The indices h, k, l, are coefficient of a _____ vector perpendicular to that plane.

C) State True / False. **04**

1) Number of atoms per unit primitive cell depends on the types of crystal system.
2) In case of tetragonal crystal system $a \neq b \neq c$.
3) In XPS, Spin orbital splitting and peak area ratios assist in element identifications.
4) Number of atoms per unit bcc system are 4.

Q.2 a) Explain Attenuated Total Reflection (ATR) **05**
b) Determine reciprocal lattice vectors for SC crystal structure. **05**
c) Give the applications of Raman spectroscopy. **04**

Q.3	**a)**	What do you mean by lattice? How many different crystals systems are possible in nature i.e. the lattice could be extended in three dimensions.	**10**
	b)	Show basic unit cell, define vectors a, b, c, or (a_1, a_2, a_3) and angles α, β, γ.	**04**
Q.4	**a)**	Explain in details basic principle, working and applications of the Raman Spectroscopy.	**10**
	b)	Explain the difference between stokes and antistokes scattering.	**04**
Q.5	**a)**	Explain in details the lattice parameters and crystal structure in tetragonal system.	**10**
	b)	Write a note on Beer Lamberts Law.	**04**
Q.6	**a)**	Draw and explain instrumentation set of FTIR spectroscopy.	**10**
	b)	Draw energy levels in Infra red absorption.	**04**
Q.7	**a)**	How we can calculate chemical shift, quantification, and depth-profiling using XPS?	**10**
	b)	How particle size has been calculated using X-ray diffractograms.	**04**

SLR-UN-478

Seat No.		Set	P

M.Sc. (Semester - II) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
STATISTICAL MECHANICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q. (1) and (2) are compulsory.
2) Answer any three questions from Q.3 to Q.7.
3) Figures to the right indicate full marks.
4) All questions carry equal marks.

Q.1 A) Select the most correct alternative **06**

1) A phase space is a _____ dimensional space.
   a) 2 b) 5
   c) 3 d) 6

2) Which of the following is a Boson?
   a) Electron b) Positron
   c) Proton d) Photon

3) On the P-T diagram of phase transition, the state in which three phases coexist is represented by a point, known as _____.
   a) Critical point b) Sublimation point
   c) Boiling point d) Triple point

4) If N is the number of particles then the standard relative deviation from mean value in case of energy fluctuation is order of _____.
   a) $\sqrt{N}$ b) $\frac{\sqrt{N}}{2}$
   c) $\frac{1}{\sqrt{N}}$ d) $\frac{2}{\sqrt{N}}$

5) In which of the following ensemble, the temperature, chemical potential and volume is same but energy and number of particles are variable?
   a) Canonical ensemble b) Microcanonical ensemble
   c) Grand canonical ensemble d) None of the above

6) Which of the following is true for FD statistics
   a) $\frac{g_i}{\exp\,(\alpha+\beta E_i)+1}$ b) $\frac{g_i}{\exp\,(\alpha-\beta E_i)-1}$
   c) $\frac{g_i}{\exp(\alpha+\beta E_i)-1}$ d) $\frac{g_i}{\exp(\alpha-\beta E_i)+1}$

B) State true or false / Fill in the blank **08**

1) For microcanonical ensemble, volume and energy of a system is variable (True/False)
2) Fermi energy level is the highest occupied energy level by fermions at absolute zero. (True/False)
3) He^4 is a spin half particle. (True/False)
4) Specific heat (C_v) at constant volume of an ideal Bose gas is discontinuous at $T = T_0$ (where T_0 is degeneracy temperature). (True/False)
5) In canonical ensemble, the relative r. m. s. energy fluctuations of system is negligible if Number of particles in the system (N) is very large (True/False)

6) λ transition in liquid helium is an example of phase transition of second kind (True/False)
7) Photons obey Pauli's exclusion principle. (True/False)
8) The pressure of Fermi gas at absolute zero temperature is proportional to 5/3 power of the density. (True/False)

Q.2 Write a short note on following:

a) Maxwell – Boltzmann statistics **05**
b) Classical ideal gas **04**
c) Phase transition **05**

Q.3 **a)** Define and explain the types of ensembles. State their importance in statistical mechanics. **10**
b) Differentiate between Fermi-Dirac statistics and Bose-Einstein statistics. **04**

Q.4 **a)** Explain the second order phase transition with examples. **08**
b) Derive the Fokker-Plank equation. **06**

Q.5 **a)** What is an ideal Bose gas? Explain the Chemical Potential and Energy of an ideal BE gas. **08**
b) Explain the law of corresponding states. **06**

Q.6 **a)** What is mean by thermodynamic fluctuation? Explain fluctuation in enthalpy and volume. **10**
b) Derive an expression for distribution of particles having half-integral spin. **04**

Q.7 **a)** State the conditions for phase equilibrium and properties of matter near critical point. **10**
b) State and explain third law of thermodynamics. **04**

SLR-UN-479

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
SEMICONDUCTOR DEVICES

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 2 to 7.
3) All questions carry equal marks.
4) Use of scientific calculator is allowed.

Q.1 Choose the correct alternative: **14**

1) The over drive factor for a BJT is given as _____.
   a) I_c / Ic_{sat} b) $I_b / I_{b\,sat}$
   c) $I_{c\,sat} / I_c$ d) $I_{b\,sat} / I_b$

2) In the linear region, power MOSFETs have I/P impedance in terms of _____.
   a) Ω b) $k\Omega$
   c) $m\Omega$ d) $\mu\Omega$

3) In the NDR devices, stability is achieved when _____.
   a) Semiconductor initially homogeneous becomes electrically heterogeneous
   b) Semiconductor initially homogeneous becomes electrically homogeneous
   c) Semiconductor initially heterogeneous becomes electrically homogeneous
   d) Semiconductor initially heterogeneous becomes electrically heterogeneous

4) If the bottom of the conduction band is located at _____ it is called τ-point.
   a) $k = \pi$ b) $k = 0$
   c) $k = -\pi$ d) $k = 2\pi$

5) In a SiO_2-Si MOS diode, the layer SiO_x is stoichiometric when _____.
   a) x = 0 b) x = 1
   c) x = 2 d) x = 3

6) The MIS interface charges are accurately & reliably measured by _____.
   a) Capacitive method b) Inductive method
   c) Both a & b d) Conductance method

7) For SiO_2- Si system, storage time τs is of the order of _____.
   a) 10^{-3} to 10^{-2} s b) 10^{-5} to 10^{-3} s
   c) 10^{-3} to 10^{-2} ms d) 10^{-5} to 10^{-3} ms

8) The dominating operating process for Laser diode is _____.
   a) Stimulated emission b) Absorption
   c) Spontaneous emission d) Reflection

9) For normal vision at the peak response _____ of the eye, 1W of radiant energy is equivalent.
   a) 600 b) 683
   c) 650 d) 693

10) The NDR is due to a field induced transfer of conduction band electrons form _____ to _____ satellite valley.
   a) Low energy – high mobility valley to high energy low mobility valley
   b) Low energy – low mobility valley to high energy low mobility valley
   c) High energy – low mobility valley to low energy high mobility valley
   d) Low energy – low mobility valley to high energy high mobility valley

11) In the MOS diodes strong inversion occurs at _____.
   a) $V < V_T$ b) $V = V_T$
   c) $V_T = 0$ d) $V = 0$

12) The figure of merit of a tunnel diode is given by,
   a) I_p b) I_o
   c) I_p / I_v d) I_v / I_p

13) The light modulation band width (Δf) is the frequency at which the light output is _____.
   a) Reduced to $1/\sqrt{2}$ b) Increased to $1/\sqrt{2}$
   c) Reduced to ½ d) Reduced to $2/\sqrt{2}$

14) A simple p-n junction diode in which both p & n sides are degenerate is ___.
   a) Tunnel diode b) Schottky diode
   c) Gunn diode d) Zener diode

Q.2 Attempt the following. (Any three) **14**
a) Explain static induction transistor.
b) Measurement of interface trapped charges.
c) Photoconductor.
d) What is flat-band shift?

Q.3 **a)** Explain how transfer efficiency can be improved with a buried channel CCD. **10**
b) Write a note on frequency response of a CCD. **04**

Q.4 **a)** Discuss with an energy band diagram and equivalent circuit, the p-n junction solar cell referred to open circuit voltage (V_{oc}), short circuit current (I_{sc}), maximum power output (P_m) & conversion efficiency (η). **10**
b) Calculate the modulation band width of a GaAs LED with a carrier life time of 100ps. **04**

Q.5 **a)** Discuss in detail the MOS-Controlled Thyristor. **10**
b) Mention its merits and demerits. **04**

Q.6 **a)** Explain 4 quadrant operation of a Triac. **10**
b) State which mode of operation is most sensitive and why? **04**

Q.7 **a)** Give a brief account of CMOS device. **07**
b) Discuss the volt-ampere characteristics of a tunnel diode. **07**

SLR-UN-480

Seat No.		Set	P

M.Sc. (Semester - III) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ATOMIC, MOLECULAR & NUCLEAR PHYSICS

Time: 2½ Hours Max. Marks: 70

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

Q.1 Objectives questions:-

A) Select the correct alternatives: **06**

1) In the nuclear shell model the spin parity of ^{15}N is given by
   a) $\frac{1^{--}}{2}$ b) $\frac{3^{--}}{2}$
   c) $\frac{1^{+}}{2}$ d) $\frac{3^{+}}{2}$

2) A nucleus with mass number 204 decay by α-emission. The Q-value of the reaction is 5.26MeV. The kinetic energy of the α-particle is
   a) 5.26MeV b) $5.26 \times \frac{200}{204}\ MeV$
   c) 2.63MeV d) $5.26 \times \frac{4}{204}\ MeV$

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

4) Pauli's Exclusion principle state that two electrons in same orbital's have
   a) Same spins b) Different spins
   c) Opposite spins d) Vertical spins

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

6) _____ type of molecules have all moment of inertia $I_A \neq I_B \neq I_C$
   a) Linear molecules b) Symmetric tops
   c) Spherical top d) Asymmetric tops

B) Fill in the blanks: **04**

1) Asymmetric tops types of molecules have all moment of inertia _____.
2) The electric quadrupole moment is negative; shape of the nuclei is _____.
3) The fine structure splitting of 3s, 3p, 2s and 2p level of hydrogen atom, the number of allowed transition between them _____.
4) The Scattering amplitude of n-p interaction is _____.

C) State true and false : **04**

1) Atomic energy levels are characterized by a quantum number n = 1, 2, 3, 4, _____ called the principal quantum number (True/False)
2) HCl and CO shows rotational spectra. (True/False)
3) If Q value of nuclear reaction is positive the reaction is endothermic. (True/False)
4) The selection rule for a rotational transition is, $\Delta J = \pm 1$ (True/False)

Q.2 A) Write short notes:-

1) Explain electric quadrapole moment for an ellipsoidal charge distribution. **05**
2) Write short note on superconductivity model? **05**
3) State impotents of Lande of factor? Calculate it for $^2D_{5/2}$ term. **04**

Q.3 A) Explain various predications of the liquid drop model. Give a brief description of semiempirical mass formula. **08**

B) Write down the predictions of the Shell Model. Give the achievements and failures of shell model? **06**

Q.4 A) Derive an expression for differential cross-section in laboratory system for p-p scattering at low energies. **08**

B) What are similarities between n-n and p-p forces? **06**

Q.5 A) Describe the compound nucleus theory of nuclear reactions. Give the experimental evidences in support of this theory **08**

B) What are nuclear reactions? Discuss various conservation laws in nuclear reactions with illustrative examples. **06**

Q.6 A) Obtain the expression of Lande splitting factor (g) for LS and JJ coupling. **08**

B) Distinguish between the energy levels of a rigid and a non rigid rotor. **06**

Q.7 A) Explain diatomic molecule as a rigid rotator. **08**

B) Obtain the expression of for diatomic molecule as a rigid rotator. **06**

SLR-UN-482

Seat No.	

Set P

M.Sc. (Semester - III) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MATERIALS PROCESSING

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

Q.1 A) Objective Questions: **06**

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

2) In resistive evaporation the filaments are usually made of refractory metals such as Tungsten or Tantalum mainly because of their
   a) Melting point b) Conductivity
   c) Ductility d) Hardness

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

4) The atmospheric pressure is equal to
   a) 760 Torr b) 1 Torr
   c) 7.6 Torr d) 76 Torr

5) The sticking coefficient depends on
   a) Substrate temperature b) Substrate area
   c) Substrate shape d) None of the above

6) DC sputtering cannot be used for deposition of
   a) Metal b) Alloy
   c) Oxide d) All above

B) State True or False:- **08**

1) Ion pump is noise free.
2) Low nucleation rate results into deposition of thin film of large grain size.
3) Quartz crystal measures thickness by measuring change in oscialltion frequency.
4) Electrodeposition can be used to deposit only conducting substrates.
5) MBE is a deposition technique for growing epitaxial film in ambient condition.
6) In chemisorptions, a strong chemical bond is formed between the adsorbate atom or molecule and the substrate.
7) In case of MOCVD we may get carbon impurity.
8) McLeod gauge can be used for continuous measurement of vacuum.

Q.2	**Write short answer:**		**14**
	a)	Sticking coefficient	**05**
	b)	Titanium sublimation pump	**05**
	c)	Cathode arc deposition	**04**
Q.3	**a)**	Discuss fundamentals of diffusion, further explain grain boundary and thin film diffusion.	**10**
	b)	How stress is generated in thin films?	**04**
Q.4	**a)**	Discuss in brief different types of sputtering.	**10**
	b)	What are different advantages and disadvantages of CVD over PVD?	**04**
Q.5	**a)**	How environment for thin film deposition and deposition parameters affect the film growth?	**10**
	b)	Discuss spray pyrolysis.	**04**
Q.6	**a)**	Discuss different types of thermal evaporation deposition methods.	**10**
	b)	Explain quartz crystal film thickness measurement.	**04**
Q.7	**a)**	Write the principle of rotary, diffusion and turbo molecular pump.	**10**
	b)	Explain different vacuum gauges?	**04**

SLR-UN-484

Seat No.	

Set P

M.Sc. (Semester - III) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
SEMICONDUCTOR DEVICES

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
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Q.1 Choose the correct alternative: **14**

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2) In the linear region, power MOSFETs have I/P impedance in terms of _____.
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3) In the NDR devices, stability is achieved when _____.
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a) Explain static induction transistor.
b) Measurement of interface trapped charges.
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d) What is flat-band shift?

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b) Write a note on frequency response of a CCD. **04**

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b) Calculate the modulation band width of a GaAs LED with a carrier life time of 100ps. **04**

Q.5 **a)** Discuss in detail the MOS-Controlled Thyristor. **10**
b) Mention its merits and demerits. **04**

Q.6 **a)** Explain 4 quadrant operation of a Triac. **10**
b) State which mode of operation is most sensitive and why? **04**

Q.7 **a)** Give a brief account of CMOS device. **07**
b) Discuss the volt-ampere characteristics of a tunnel diode. **07**

SLR-UN-485

Seat No.	

Set P

M.Sc. (Semester - III) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ATOMIC, MOLECULAR & NUCLEAR PHYSICS

Time: 2½ Hours Max. Marks: 70

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

Q.1 Objectives questions:-

A) Select the correct alternatives: **06**

1) In the nuclear shell model the spin parity of ^{15}N is given by
   a) $\frac{1^{--}}{2}$ b) $\frac{3^{--}}{2}$
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3) The magic number in nuclear physics arises mainly due to
   a) Dipole-dipole interactions b) Short character of nuclear force
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4) Pauli's Exclusion principle state that two electrons in same orbital's have
   a) Same spins b) Different spins
   c) Opposite spins d) Vertical spins

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

6) _____ type of molecules have all moment of inertia $I_A \neq I_B \neq I_C$
   a) Linear molecules b) Symmetric tops
   c) Spherical top d) Asymmetric tops

B) Fill in the blanks: **04**

1) Asymmetric tops types of molecules have all moment of inertia _____.
2) The electric quadrupole moment is negative; shape of the nuclei is _____.
3) The fine structure splitting of 3s, 3p, 2s and 2p level of hydrogen atom, the number of allowed transition between them _____.
4) The Scattering amplitude of n-p interaction is _____.

C) State true and false : **04**

1) Atomic energy levels are characterized by a quantum number n = 1, 2, 3, 4, _____ called the principal quantum number (True/False)
2) HCl and CO shows rotational spectra. (True/False)
3) If Q value of nuclear reaction is positive the reaction is endothermic. (True/False)
4) The selection rule for a rotational transition is, $\Delta J = \pm 1$ (True/False)

Q.2 A) Write short notes:-

1) Explain electric quadrapole moment for an ellipsoidal charge distribution. **05**
2) Write short note on superconductivity model? **05**
3) State impotents of Lande of factor? Calculate it for $^2D_{5/2}$ term. **04**

Q.3 A) Explain various predications of the liquid drop model. Give a brief description of semiempirical mass formula. **08**

B) Write down the predictions of the Shell Model. Give the achievements and failures of shell model? **06**

Q.4 A) Derive an expression for differential cross-section in laboratory system for p-p scattering at low energies. **08**

B) What are similarities between n-n and p-p forces? **06**

Q.5 A) Describe the compound nucleus theory of nuclear reactions. Give the experimental evidences in support of this theory **08**

B) What are nuclear reactions? Discuss various conservation laws in nuclear reactions with illustrative examples. **06**

Q.6 A) Obtain the expression of Lande splitting factor (g) for LS and JJ coupling. **08**

B) Distinguish between the energy levels of a rigid and a non rigid rotor. **06**

Q.7 A) Explain diatomic molecule as a rigid rotator. **08**

B) Obtain the expression of for diatomic molecule as a rigid rotator. **06**

SLR-UN-486

Seat No.	

Set P

M.Sc. (Semester - III) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
DIELECTRIC & FERROELECTRIC PROPERTIES OF MATERIALS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any 3 questions from Q. 3 to 7.
3) All questions carry equal marks.
4) Use of non-programmable calculator is allowed.

Q.1 A) Select Correct alternatives: **08**

1) What symmetry element must be absent for a material to be ferroelectric?
   a) An axis of rotation
   b) A mirror plane
   c) A centre of symmetry
   d) An improper axis of rotation

2) Which of these is not a correct definition of polarization?
   a) The net dipole moment per unit volume
   b) The surface charge per unit area
   c) The movement of atoms giving rise to a dipole moment
   d) The net charge per dipole moment

3) The polarization of a sold which contain N number of particles per unit volume is equal to
   a) $P_e = N\alpha E$
   b) $P_e = 2\,N\alpha E$
   c) $P_e = N\alpha^2 E$
   d) $P_e = N\alpha^2 E^2$

4) The internal or Lorentz field is equal to
   a) $E_i = E + E_c$
   b) $E_i = \frac{P}{3\varepsilon_0}$
   c) $E_i = E + \frac{P^2}{3\varepsilon_0}$
   d) $E_i = E + \frac{P}{3\varepsilon_0}$

5) For a given dielectric, as the temperature increases, the ionic polarizability
   a) Increases
   b) Decreases
   c) Remains unaltered
   d) None of these

6) The unit of dipole moment per unit volume is
   a) C/m
   b) C/m^2
   c) C/m^3
   d) Coulomb

7) Applying a mechanical stress to a piezoelectric does not cause which of these?
   a) The formation of a dipole moment
   b) The movement of atoms
   c) Development of polarization
   d) The generation of an internal current

8) In a ferroelectric material, as the applied field is gradually reduced to zero, the polarization still left is known as
   a) Remanent polarization
   b) Coercive polarization
   c) Zero polarization
   d) Positive polarization

B) State whether the following statement is True or False: **06**

1) For a single-point charge with total net charge $+Q$ in free space, F can be written as, $F = \frac{Q}{4\pi\varepsilon_0 r^2}$
2) The amount of rotation in angle is proportional to the magnetic filed H and is given by $\theta = \frac{V}{HL}$
3) Helmholtz free-energy function A, which is given by $A = U - TS$
4) Crystals formed by polar molecules with a centrosymmetric structure will exhibit a piezoelectric effect
5) Pyroelectricity occurs only when the material exhibits spontaneous polarization.
6) $\nabla \times E = -\frac{\partial B}{\partial t}$

Q.2 Write a short note on: **14**

a) Polar and nonpolar dielectrics **04**
b) Cole-Cole plot **05**
c) Magneto-Optic effect **05**

Q.3 **a)** Give an account for Kramers – Kronig Relations. **08**
b) Write short note on Acousto-Optic effect. **06**

Q.4 **a)** Discuss in detail the vibrational atomic/ ionic polarization mechanism. **08**
b) Write short note PTC materials. **06**

Q.5 **a)** Give an account for Time-Dependent Electric Polarization. **08**
b) Write short note on conducting materials. **06**

Q.6 **a)** Give an account for phenomenological approach to piezoelectric effects. **08**
b) Write short note on $BaTiO_3$ and its unit cell **06**

Q.7 **a)** Give an account for spontaneous, space charge and hopping polarization. **08**
b) Write short note on dielectric relaxation phenomena. **06**

SLR-UN-487

Seat No.	

Set P

M.Sc. (Semester - III) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MATERIALS PROCESSING

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

Q.1 A) Choose the correct alternative: **06**

1) DC sputtering cannot be used for deposition of
   a) Metal b) Alloy
   c) Oxide d) All above

2) In resistive evaporation the filaments are usually made of refractory metals such as Tungsten or Tantalum mainly because of their
   a) Melting point b) Conductivity
   c) Ductility d) Hardness

3) The atmospheric pressure is equal to
   a) 760 Torr b) 1 Torr
   c) 7.6 Torr d) 76 Torr

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

5) The sticking coefficient depends on
   a) Substrate temperature b) Substrate area
   c) Substrate shape d) None of the above

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

B) State True or False/ Fill in the blanks: **08**

1) Ion pump is noise free.
2) Low nucleation rate results into deposition of thin film of large grain size.
3) Quartz crystal measures thickness by measuring change in oscillation frequency.
4) Electrodeposition can be used to deposit only conducting substrates.
5) MBE is a deposition technique for growing epitaxial film in ambient condition.
6) In chemisorption, a strong chemical bond is formed between the adsorbate atom or molecule and the substrate.
7) In case of MOCVD we may get carbon impurity.
8) McLeod gauge can be used for continuous measurement of vacuum.

Q.2	**Write a short note on:**		
	a)	Plasma enhanced CVD	**05**
	b)	Titanium sublimation pump	**05**
	c)	Grain boundary diffusion	**04**
Q.3	**a)**	Write the principles of rotary, diffusion and turbo molecular pump.	**10**
	b)	Explain working of penning guage, in which vacuum range it can be used?	**04**
Q.4	**a)**	Discuss mechanical, electrical and optical properties of thin films.	**10**
	b)	Explain quartz crystal film thickness measurement.	**04**
Q.5	**a)**	Explain in detail different types of sputtering. How AC (RF) sputtering is helpful for depositing oxide thin films?	**10**
	b)	Discuss spray pyrolysis.	**04**
Q.6	**a)**	Discuss in brief different types of CVD.	**10**
	b)	What are different advantages and disadvantages of CVD over PVD?	**04**
Q.7	**a)**	Discuss fundamentals of diffusion, further explain grain boundary and thin film diffusion.	**10**
	b)	How stress is generated in thin films?	**04**

SLR-UN-488

Seat No.		Set	P

M.Sc. (Semester - IV) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MICROELECTRONICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q. (1) and (2) are compulsory.
2) Answer any three questions from Q.3 to Q.7.
3) All questions carry equal marks.
4) Use of nonprogrammable calculator is allowed.

Q.1 Select the most correct alternative. **14**

1) For microelectronic applications, growth of single crystal Si along _____ is favored.
   a) 110 b) 100
   c) 101 d) 111

2) The effective impurity concentration for a reliable diffusion of boron in Si is _____ atoms / cm^3.
   a) 10^{19} b) 10^{18}
   c) 10^{20} d) 10^{21}

3) Molecular Beam Epitaxy is a _____ process.
   a) CVD b) Non-CVD
   c) PVD d) VPE

4) In MOS-devices, the gate electrode used is usually _____.
   a) Polysilicon b) Single Crystal Silicon
   c) Multilayered Silicon d) Stoichiometric Nitrides

5) Poly-Si deposition using CVD follows _____ behavior.
   a) Arrhenius b) Ohmic
   c) Kirchooff's d) Exponential

6) Out of the following oxide charges, which are the orientation dependent?
   a) Fixed Oxide Charges b) Interface Trapped Charges
   c) Mobile Ionic Charges d) Oxide Trapped Charges

7) Al forms a _____ contact with Silicon.
   a) Non-Ohmic b) Ohmic
   c) Abrupt d) Rectifying

8) Glassivation is usually done by _____.
   a) CVD b) CBD
   c) ECD d) MBE

9) Which Photoresist is specially developed for LSI / VLSI circuit fabrication
   a) Iso-fine Kodak-820 b) Novolac
   c) Hunt-way HPR-256 d) Iso-fine-Kodak-280

10) In a constant source diffusion, surface concentration is always
   a) Decreasing b) Increasing
   c) Constant d) Both a) and b)

11) Fick's first law of diffusion is expressed as _____.
   a) $j = D\,\partial N/\partial x$ b) $j = -\partial^2 N/\partial x^2$
   c) $j = -D\,\partial N/\partial x$ d) $j = -\partial N/\partial x$

12) _____ is used as a selective mask for oxidation of Si.
   a) Si_3N_4 b) SiO_2
   c) Si_2N_3 d) SiN_3

13) Si_3N_4 forms a Zero stress material with _____.
   a) SiO_2 b) Si_2O_3
   c) Si_3O_4 d) SiN_3

14) Glue layer in metallization is the, reduction of SiO_2_____.
   a) W b) Al
   c) Mo d) Ti

Q.2 **Write a note on. (Any Three)** **14**
a) Etch back effect
b) Substitutional diffusion
c) Multilevel metallization
d) Oxide charges

Q.3 **a)** Give a brief account of Vapor Phase Epitaxy for the growth of single crystal silicon. **10**
b) What is a negative Photoresist? **04**

Q.4 **a)** State and Explain Fick's 1st law of diffusion. **10**
b) Explain in brief an interstitial diffusion. **04**

Q.5 **a)** Discuss in brief the Molecular Beam Epitaxy for the epitaxial growth of Si. **10**
b) Mention the salient feature of MBE over CVD. **04**

Q.6 What is Oxidation? Discuss Deal and Groves model for kinetics of Si-Oxidation. **14**

Q.7 **a)** Give an account of gas source system for diffusion of Boron in Silicon. **10**
b) Write a note on wire bonding. **04**

SLR-UN-489

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
PHYSICS OF NANO MATERIALS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

Q.1 A) Choose the Correct alternatives: **08**

1) If the size of the metal nanoparticles decreases then the position of the SPR peak
   a) shifts towards lower wavelength
   b) shifts towards higher wavelength
   c) remains same
   d) none of the above

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

3) The basic principle of AFM is
   a) change in force due to change in distance
   b) change in current due to change in distance
   c) change in shape due to change in distance
   d) change in size due to change in distance

4) If an electron is confined in limited space then the allowed energy states are
   a) continuous b) discrete
   c) limited d) none

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

6) In SEM the morphology of the sample is achieved with the help of
   a) secondary electrons b) primary electrons
   c) emitted electrons d) photoelectrons

7) DC sputtering cannot be used for deposition of
   a) Metal b) Alloy
   c) Oxide d) All above

8) Nanotubes usually form in bundles. Which is the best description of such a bundle?
   a) The tubes are aligned, axes parallel, with van der Waals forces operating between adjacent tubes
   b) The tubes are connected together by covalent C-C bonds
   c) The tubes are randomly organized, with the axes of the tubes lying in random directions
   d) The bundles are of discrete sizes, and dipole-dipole forces hold the tubes together

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

1) The melting point of the nanoparticles is smaller than the bulk sized particle.
2) In AFM, the sample is mounted on a piezoelectric tube.
3) The electron mobility in semiconductors can be greatly decreased by the formation of polarons.
4) The Drude model neglects any long-range interaction between the electron and the ions or between the electrons.
5) The SPR observed for insulator nanoparticles.
6) The ball milling is a top down method

Q.2 Write a short note on: **14**

a) Polaron conduction mechanism **05**

b) Quantum confinement **05**

c) Molecular machines **04**

Q.3 **a)** What is magnetron sputtering? Explain the basic difference between the magnetron sputtering and conventional sputtering. **10**

b) "In principle, AFM resembles the record player as well as the stylus profilometer"-Explain **04**

Q.4 Explain how endo-fullerenes can be used as one-dimensional metal-semiconductor junctions. Explain how a CNT can be bent to a ring. **14**

Q.5 **a)** "Template- assisted synthesis is a very efficient tool to grow highly ordered and nano-wires/rods" – Explain **10**

b) Write a note on BN nanotubes **04**

Q.6 Derive the AC electrical conductivity of a metal according to Drude model. Explain the inadequacies of Drude model and write the assumptions made in Free Electron model. **14**

Q.7 Show that in STM the tunneling current varies exponentially as the tip-sample distance. **14**

SLR-UN-490

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MAGNETIC MATERIALS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.
4) Use of non-programmable calculator is allowed.

Q.1 A) Select Correct alternatives: **08**

1) Above the Neel Temperature (T_N),
   a) The diamagnetism vanishes
   b) The paramagnetism vanishes
   c) The ferrimagnetism vanishes
   d) The antiferromagnetism vanishes

2) The typical volume of a domain is
   a) $10^{-2}\ m^3$ b) $10^{-6}\ m^3$
   c) $10^{-10}\ m^3$ d) $10^{+6}\ m^3$

3) The $SrFe_{12}O_{19}$ is a
   a) Hexaferrite b) Spinel Ferrite
   c) Dielectric d) Superconductor

4) For a ferromagnet
   a) Exchange integral J is positive and spins are parallel
   b) J is negative and spins are parallel
   c) J is negative and spins are antiparallel
   d) J is positive

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

6) Magnetic Susceptibility $(\chi) =$ - 1 for a
   a) Metal b) Semiconductor
   c) Insulator d) Superconductor

7) 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

8) The typical value of the thickness of the Bloch wall is
   a) 1Å b) 10 Å
   c) 100 Å d) 1000 Å

B) State True or False **06**

1) Curie law $\chi = C/T$ is valid for paramagnet.
2) The typical volume of a domain is $10^{-10}\ m^3$.
3) Magnetic induction B and magnetic field intensity H are related by B = μmH.
4) The magnetic spin arrangements are explained using Exchange interaction energy.
5) Exchange interaction between any two electrons is $E_{ex} = -2\,J_{ex}\,S_i\,S_j$
6) Fe_3O_4 is a magnetostrictive material.

Q.2 Write a short note on: **14**

a) ΔE Effect **04**
b) Physical Origin of Crystal Anisotropy **05**
c) Spinel Ferrites **05**

Q.3 a) Explain in detail the quantum theory of paramagnetism. **08**
b) Explain the magnetic properties of garnets with suitable example. **06**

Q.4 a) Discuss the magnetic characteristics of diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic materials on account of their magnetic moments as well as magnetic susceptibilities. **08**
b) Write a short note on antiferromagnetic alloys. **06**

Q.5 a) Give an account for molecular filed theory of ferromagnetism. **08**
b) Magnetic measurements in closed circuits. **06**

Q.6 a) Define magnetostriction and discuss the physical origin of magnetostriction **08**
b) Exchange forces **06**

Q.7 a) Explain the molecular field theory above and below T_N in antiferromagnetism. **08**
b) Write a short note on domain wall motion. **06**

SLR-UN-491

Seat No.	

Set P

M.Sc. (Semester - IV) (New) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ADVANCED TECHNIQUES OF MATERIALS CHARACTERIZATION

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

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

1) Raman spectroscopy deals with _____.
   a) Transition of electron between two vibrational energy states
   b) Transition of the electron between two electronic energy states
   c) Absorption of electron from source
   d) Photoelectric effect in IR range of electromagnetic spectrum

2) The resonance frequency range for electron in case of ESR is close to _____.
   a) 10 GHz b) 100 MHz
   c) 100 GHz d) 100 Hz

3) Absorption of energy from electromagnetic radiation by a molecules gives
   a) Stokes line b) anti Stokes lines
   c) Rayleigh line d) None of these

4) Charge on X-ray is _____
   a) $+1.6 \times 10^{-19} C$ b) $-1.6 \times 10^{-19} C$
   c) Neutral d) $9.1 \times 10^{-31} C$

5) In scanning electron microscope _____ are impinged on the sample surface to get the surface information.
   a) Electrons b) Photons
   c) X-rays d) Phonons

6) The energy of the back scattered electrons in SEM is _____ that of secondary electrons.
   a) Equal to b) Greater than
   c) Less than d) None of these

7) Histogram is plot of _____
   a) Number of particles Vs size of the particles
   b) Energy of the particle Vs size of the particles
   c) Brightness of the particle Vs size of the particle
   d) Intensity Vs Energy

8) Wavelength of the electron in 200 kV TEM is _____
   a) 2.5 pm b) 2.5 A
   c) 2.5 nm d) 2.5 mm

B) State True or False **06**

1) In Auger electron spectroscopy, electron is emitted during secondary processes after emission of first electron.
2) For a linear molecule, symmetric stretching mode is IR active and Raman inactive.
3) AFM image looks brown in colour because the sample emits brown coloured radiations.
4) It is possible to record STM images in normal environmental conditions.
5) While analyzing SAED pattern energy of the scattered energy is mapped and analyzed.
6) It is possible to image an atom using SEM.

Q.2 Write short note on: **14**

a) Resonance condition in ESR & NMR
b) IR and Raman active modes
c) Contact and non contact modes in AFM

Q.3 **a)** Explain the process of image formation in scanning Tunneling Microscopy (STM). Also explain different parts and their working in detail. **10**

b) Explain what is selected area electron diffraction (SAED) also elucidate its use in materials characterization **04**

Q.4 **a)** Explain classical and quantum approach used to understand Raman Spectroscopy. **10**

b) Explain acoustic and optical phonon modes. **04**

Q.5 **a)** What is EPR condition? Explain in detail continuous wave EPR and EPR line width. **08**

b) Explain the necessity of high resolution NMR spectrometer for solid samples, if any **06**

Q.6 **a)** Draw the block diagram of AFM and explain the working of each part of the microscope. **08**

b) Draw the force curve, which governs the image formation in AFM and explain the same. **06**

Q.7 **a)** What do you mean by surface? What are different probes used for surface characterization. What is order of vacuum required to record the XPS spectra and why? **08**

b) Explain what are bright field and dark field images in TEM. How do they are formed? **06**

SLR-UN-493

Seat No.		Set	P

M.Sc. (Semester - IV) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MICROELECTRONICS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q. (1) and (2) are compulsory.
2) Answer any three questions from Q.3 to Q.7.
3) All questions carry equal marks.
4) Use of nonprogrammable calculator is allowed.

Q.1 Select the most correct alternative. **14**

1) For microelectronic applications, growth of single crystal Si along _____ is favored.
   a) 110 b) 100
   c) 101 d) 111

2) The effective impurity concentration for a reliable diffusion of boron in Si is _____ atoms / cm^3.
   a) 10^{19} b) 10^{18}
   c) 10^{20} d) 10^{21}

3) Molecular Beam Epitaxy is a _____ process.
   a) CVD b) Non-CVD
   c) PVD d) VPE

4) In MOS-devices, the gate electrode used is usually _____.
   a) Polysilicon b) Single Crystal Silicon
   c) Multilayered Silicon d) Stoichiometric Nitrides

5) Poly-Si deposition using CVD follows _____ behavior.
   a) Arrhenius b) Ohmic
   c) Kirchooff's d) Exponential

6) Out of the following oxide charges, which are the orientation dependent?
   a) Fixed Oxide Charges b) Interface Trapped Charges
   c) Mobile Ionic Charges d) Oxide Trapped Charges

7) Al forms a _____ contact with Silicon.
   a) Non-Ohmic b) Ohmic
   c) Abrupt d) Rectifying

8) Glassivation is usually done by _____.
   a) CVD b) CBD
   c) ECD d) MBE

9) Which Photoresist is specially developed for LSI / VLSI circuit fabrication
   a) Iso-fine Kodak-820 b) Novolac
   c) Hunt-way HPR-256 d) Iso-fine-Kodak-280

10) In a constant source diffusion, surface concentration is always
   a) Decreasing b) Increasing
   c) Constant d) Both a) and b)

11) Fick's first law of diffusion is expressed as _____.
   a) $j = D\,\partial N/\partial x$ b) $j = -\partial^2 N/\partial x^2$
   c) $j = -D\,\partial N/\partial x$ d) $j = -\partial N/\partial x$

12) _____ is used as a selective mask for oxidation of Si.
   a) Si_3N_4 b) SiO_2
   c) Si_2N_3 d) SiN_3

13) Si_3N_4 forms a Zero stress material with _____.
   a) SiO_2 b) Si_2O_3
   c) Si_3O_4 d) SiN_3

14) Glue layer in metallization is the, reduction of SiO_2_____.
   a) W b) Al
   c) Mo d) Ti

Q.2 **Write a note on. (Any Three)** **14**
a) Etch back effect
b) Substitutional diffusion
c) Multilevel metallization
d) Oxide charges

Q.3 **a)** Give a brief account of Vapor Phase Epitaxy for the growth of single crystal silicon. **10**
b) What is a negative Photoresist? **04**

Q.4 **a)** State and Explain Fick's 1st law of diffusion. **10**
b) Explain in brief an interstitial diffusion. **04**

Q.5 **a)** Discuss in brief the Molecular Beam Epitaxy for the epitaxial growth of Si. **10**
b) Mention the salient feature of MBE over CVD. **04**

Q.6 What is Oxidation? Discuss Deal and Groves model for kinetics of Si-Oxidation. **14**

Q.7 **a)** Give an account of gas source system for diffusion of Boron in Silicon. **10**
b) Write a note on wire bonding. **04**

SLR-UN-494

Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
PHYSICS OF NANO MATERIALS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

Q.1 A) Choose the Correct alternatives: **08**

1) If the size of the metal nanoparticles decreases then the position of the SPR peak
   a) shifts towards lower wavelength
   b) shifts towards higher wavelength
   c) remains same
   d) none of the above

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

3) The basic principle of AFM is
   a) change in force due to change in distance
   b) change in current due to change in distance
   c) change in shape due to change in distance
   d) change in size due to change in distance

4) If an electron is confined in limited space then the allowed energy states are
   a) continuous b) discrete
   c) limited d) none

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

6) In SEM the morphology of the sample is achieved with the help of
   a) secondary electrons b) primary electrons
   c) emitted electrons d) photoelectrons

7) DC sputtering cannot be used for deposition of
   a) Metal b) Alloy
   c) Oxide d) All above

8) Nanotubes usually form in bundles. Which is the best description of such a bundle?
   a) The tubes are aligned, axes parallel, with van der Waals forces operating between adjacent tubes
   b) The tubes are connected together by covalent C-C bonds
   c) The tubes are randomly organized, with the axes of the tubes lying in random directions
   d) The bundles are of discrete sizes, and dipole-dipole forces hold the tubes together

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

1) The melting point of the nanoparticles is smaller than the bulk sized particle.
2) In AFM, the sample is mounted on a piezoelectric tube.
3) The electron mobility in semiconductors can be greatly decreased by the formation of polarons.
4) The Drude model neglects any long-range interaction between the electron and the ions or between the electrons.
5) The SPR observed for insulator nanoparticles.
6) The ball milling is a top down method

Q.2 Write a short note on: **14**

a) Polaron conduction mechanism **05**

b) Quantum confinement **05**

c) Molecular machines **04**

Q.3 a) What is magnetron sputtering? Explain the basic difference between the magnetron sputtering and conventional sputtering. **10**

b) "In principle, AFM resembles the record player as well as the stylus profilometer"-Explain **04**

Q.4 Explain how endo-fullerenes can be used as one-dimensional metal-semiconductor junctions. Explain how a CNT can be bent to a ring. **14**

Q.5 a) "Template- assisted synthesis is a very efficient tool to grow highly ordered and nano-wires/rods" – Explain **10**

b) Write a note on BN nanotubes **04**

Q.6 Derive the AC electrical conductivity of a metal according to Drude model. Explain the inadequacies of Drude model and write the assumptions made in Free Electron model. **14**

Q.7 Show that in STM the tunneling current varies exponentially as the tip-sample distance. **14**

SLR-UN-495

Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
MAGNETIC MATERIALS

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.
4) Use of non-programmable calculator is allowed.

Q.1 A) Select Correct alternatives: **08**

1) Above the Neel Temperature (T_N),
   a) The diamagnetism vanishes
   b) The paramagnetism vanishes
   c) The ferrimagnetism vanishes
   d) The antiferromagnetism vanishes

2) The typical volume of a domain is
   a) $10^{-2}\ m^3$ b) $10^{-6}\ m^3$
   c) $10^{-10}\ m^3$ d) $10^{+6}\ m^3$

3) The $SrFe_{12}O_{19}$ is a
   a) Hexaferrite b) Spinel Ferrite
   c) Dielectric d) Superconductor

4) For a ferromagnet
   a) Exchange integral J is positive and spins are parallel
   b) J is negative and spins are parallel
   c) J is negative and spins are antiparallel
   d) J is positive

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

6) Magnetic Susceptibility $(\chi) =$ - 1 for a
   a) Metal b) Semiconductor
   c) Insulator d) Superconductor

7) 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

8) The typical value of the thickness of the Bloch wall is
   a) 1Å b) 10 Å
   c) 100 Å d) 1000 Å

B) State True or False **06**

1) Curie law $\chi = C/T$ is valid for paramagnet.
2) The typical volume of a domain is $10^{-10}\ m^3$.
3) Magnetic induction B and magnetic field intensity H are related by B = μmH.
4) The magnetic spin arrangements are explained using Exchange interaction energy.
5) Exchange interaction between any two electrons is $E_{ex} = -2\,J_{ex}\,S_i\,S_j$
6) Fe_3O_4 is a magnetostrictive material.

Q.2 Write a short note on: **14**

a) ΔE Effect **04**
b) Physical Origin of Crystal Anisotropy **05**
c) Spinel Ferrites **05**

Q.3 a) Explain in detail the quantum theory of paramagnetism. **08**
b) Explain the magnetic properties of garnets with suitable example. **06**

Q.4 a) Discuss the magnetic characteristics of diamagnetic, paramagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic materials on account of their magnetic moments as well as magnetic susceptibilities. **08**
b) Write a short note on antiferromagnetic alloys. **06**

Q.5 a) Give an account for molecular filed theory of ferromagnetism. **08**
b) Magnetic measurements in closed circuits. **06**

Q.6 a) Define magnetostriction and discuss the physical origin of magnetostriction **08**
b) Exchange forces **06**

Q.7 a) Explain the molecular field theory above and below T_N in antiferromagnetism. **08**
b) Write a short note on domain wall motion. **06**

SLR-UN-496

Seat No.	

Set P

M.Sc. (Semester - IV) (Old) (CBCS) Examination Mar/Apr-2018
Physics (Materials Science)
ADVANCED TECHNIQUES OF MATERIALS CHARACTERIZATION

Time: 2½ Hours Max. Marks: 70

Instructions: 1) Q.1 and Q.2 are compulsory.
2) Attempt any three questions from Q. 3 to 7.
3) All questions carry equal marks.

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

1) Raman spectroscopy deals with _____.
   a) Transition of electron between two vibrational energy states
   b) Transition of the electron between two electronic energy states
   c) Absorption of electron from source
   d) Photoelectric effect in IR range of electromagnetic spectrum

2) The resonance frequency range for electron in case of ESR is close to _____.
   a) 10 GHz b) 100 MHz
   c) 100 GHz d) 100 Hz

3) Absorption of energy from electromagnetic radiation by a molecules gives
   a) Stokes line b) anti Stokes lines
   c) Rayleigh line d) None of these

4) Charge on X-ray is _____
   a) $+1.6 \times 10^{-19} C$ b) $-1.6 \times 10^{-19} C$
   c) Neutral d) $9.1 \times 10^{-31} C$

5) In scanning electron microscope _____ are impinged on the sample surface to get the surface information.
   a) Electrons b) Photons
   c) X-rays d) Phonons

6) The energy of the back scattered electrons in SEM is _____ that of secondary electrons.
   a) Equal to b) Greater than
   c) Less than d) None of these

7) Histogram is plot of _____
   a) Number of particles Vs size of the particles
   b) Energy of the particle Vs size of the particles
   c) Brightness of the particle Vs size of the particle
   d) Intensity Vs Energy

8) Wavelength of the electron in 200 kV TEM is _____
   a) 2.5 pm b) 2.5 A
   c) 2.5 nm d) 2.5 mm

B) State True or False **06**

1) In Auger electron spectroscopy, electron is emitted during secondary processes after emission of first electron.
2) For a linear molecule, symmetric stretching mode is IR active and Raman inactive.
3) AFM image looks brown in colour because the sample emits brown coloured radiations.
4) It is possible to record STM images in normal environmental conditions.
5) While analyzing SAED pattern energy of the scattered energy is mapped and analyzed.
6) It is possible to image an atom using SEM.

Q.2 Write short note on: **14**

a) Resonance condition in ESR & NMR
b) IR and Raman active modes
c) Contact and non contact modes in AFM

Q.3 **a)** Explain the process of image formation in scanning Tunneling Microscopy (STM). Also explain different parts and their working in detail. **10**

b) Explain what is selected area electron diffraction (SAED) also elucidate its use in materials characterization **04**

Q.4 **a)** Explain classical and quantum approach used to understand Raman Spectroscopy. **10**

b) Explain acoustic and optical phonon modes. **04**

Q.5 **a)** What is EPR condition? Explain in detail continuous wave EPR and EPR line width. **08**

b) Explain the necessity of high resolution NMR spectrometer for solid samples, if any **06**

Q.6 **a)** Draw the block diagram of AFM and explain the working of each part of the microscope. **08**

b) Draw the force curve, which governs the image formation in AFM and explain the same. **06**

Q.7 **a)** What do you mean by surface? What are different probes used for surface characterization. What is order of vacuum required to record the XPS spectra and why? **08**

b) Explain what are bright field and dark field images in TEM. How do they are formed? **06**