SLR-MH – 475

Seat No.	

M.Sc. (Part – I) (Semester – I) (New) (CBCS) Examination, 2016
PHYSICS (Material Science)
Mathematical Techniques (Paper – I)

Day and Date : Tuesday, 29-3-2016 Max. Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

Instructions *: 1) Q. No.* ***1*** *and Q. No.* ***2*** *are* ***compulsory****.*
2) Answer ***any three*** *questions from Q. No.* ***3*** *to Q. No.* ***7****.*
3) ***Use*** *of non programmable calculator is* ***allowed****.*
4) ***All*** *questions carry* ***equal*** *marks.*

1. 1) Choose the correct alternative : **6**

i) The solution of Integral of $(D + 1)^3 y =$ is $y =$ _____

a) $c_1e^{-x} + c_2e^{-x} + c_3e^{-x}$ b) $(c_1x^2 + c_2x + c_3)e^{-x}$

c) $\frac{x^3}{3!}e^{2x}$ d) 0

ii) The vectors X_1, X_2 and X_3 are said to be Linearly Dependent if for $c_1X_1 + c_2X_2 + c_3X_3 = 0$ we get _____

a) $c_1 = 0$, $c_2 = 0$ and $c_3 = 0$

b) $X_1 = 0$, $X_2 = 1$ and $X_3 = 1$

c) $X_1.X_2 = X_3$, $X_2.X_3 = X_1$ and $X_3.X_1 = X_2$

d) At least on of c_1, c_2, c_3 is not equal to zero

iii) Inverse Laplace Transform of $\frac{1}{(s+b)^2} =$ _____

a) $e^{-bt}\frac{t}{2!}$ b) $e^{bt}\frac{t^3}{2}$ c) $e^{-bt}\frac{t^2}{3!}$ d) $e^{bt}\frac{t^3}{3}$

iv) Fourier Cosine Integral of f(s) is given by _____

a) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\sin ws.dxds$ b) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\cos ws.dxds$

c) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\sin ws.dwds$ d) $\frac{2}{\pi}\int_0^\infty \cos wx \int_0^\infty f(s)\cos ws.dwds$

P.T.O.

v) $(a + bi)^{3/4}$ will have _____ no. of values.

a) 2 b) 3

c) 4 d) 12

vi) The value of f(z) = u + iv is analytic function then f′ (z) = _____

a) $v_y - iu_y$ b) $u_x - iv_x$

c) $v_y + iv_x$ d) $u_y + iv_x$

2) State **true** or **false** : **8**

i) $L\{e^{-bt}f(t)\} = L|\{f(t)\}|_{s-b}$.

ii) If the vectors are Linearly dependent then one vector can be expressed as linear combination of others.

iii) The Fourier series of f(x) in (–a, a) will involve sine terms if f(x) is odd.

iv) $\frac{1}{D^2+3}\cos x$ is equal to $-\frac{1}{2}\cos x$.

v) Fourier expansion of $x^2 - x^3$ in (–1, 1) has only Cosine Terms.

vi) The eigen values of A are 1, 2, 3 the eigen values of A^{-1} are 1, 1/2, 1/3.

vii) If f(z) is analytic function and f′ (z) is continuous at all points inside and on a simple closed curve C, then $\int_C f(z)dz = 0$.

viii) If u is harmonic then $u_{xx} + u_{yy} = 0$.

2. Write short notes on :

1) Write a note on Vector spaces and subspaces. **5**

2) What are non homogenous differential equations with constant coefficient explain with examples. **4**

3) Define Linear Dependance, Independence and Orthogonality of the vectors. **5**

3. 1) Evaluate $\int_C \frac{e^{2z}dz}{(z-1)^4}$ where C is circle |Z| = 2. **6**

2) Solve $(D^2 - 7D - 6)y = x^2$. **8**

4. 1) Find Fourier Series of $f(x) = 2 - \frac{x^2}{2}$ in (0, 2). **10**

   2) Prove that $(a + ib)^n + (a - ib)^n = (a^2 + b^2)^{n/2+1}\cos(n \tan^{-1}(b/a))$. **4**

5. 1) Examine the vector for linear dependance and independence hence check whether following vectors will form a bases for R^3.
   [1, 0, –3], [3, 1, –3], [–2, –2, 1]. **8**

   2) Solve $y'' + 9y' + 8y = 0$ at $y(0) = 2,\ y'(0) = 1$ and find the limit, as $t \to \infty$, of the solution. **6**

6. 1) Find Fourier cosine Transform of $f(x) = e^{-x^2}$. **8**

   2) Diagonalize the matrix if possible $\begin{pmatrix} 6 & -2 & -1 \\ -2 & 6 & -1 \\ -1 & -1 & 5 \end{pmatrix}$. **6**

7. 1) Using C-R equations show that $f(z) = ze^z$ is analytic in entire z-plane. **6**

   2) Let $a = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$, $b = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$, $c = \begin{pmatrix} 2/3 \\ -1 \\ 4/3 \end{pmatrix}$ and $d = \begin{pmatrix} -1 \\ 6 \\ 5 \end{pmatrix}$.

      1) Compute $\frac{a.b}{a.a}$.

      2) Find $\| a \|, \| b \|$.

      3) Show that d is orthogonal to c. **8**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2016
PHYSICS (Materials Science)
(Paper – II) (New) (CBCS)
Condensed Matter Physics

Day and Date : Thursday, 31-3-2016 Total Marks : 70
Time :10.30 a.m. to 1.00 p.m.

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

1. A) Select correct alternative : **8**

1) Intrinsic semiconductor material is characterized by a valence shell of how many electrons ?

A) 1 B) 2 C) 4 D) 6

2) What causes the depletion region ?

A) Doping B) Diffusion
C) Barrier potential D) Ions

3) What is an energy gap ?

A) The space between two orbital shells
B) The energy equal to the energy acquired by an electron passing a 1V electric field
C) The energy band in which electrons can move freely
D) An energy level at which an electron can exist

4) Silicon atoms combine into an orderly pattern called a

A) covalent bond B) crystal
C) semiconductor D) valence orbit

5) In “n” type material, majority carriers would be

A) holes B) dopants C) slower D) electrons

P.T.O.

6) Elements with 1, 2 or 3 valence electrons usually make excellent

A) conductors B) semiconductors

C) insulators D) neutral

7) Which of the following are the properties of superconductors ?

A) They are diamagnetic in nature

B) They have zero resistivity

C) They have infinite conductivity

D) All of the above

8) In superconductivity, the electrical resistance of material becomes

A) Zero B) Infinite

C) Finite D) All of the above

B) State **True** or **False** : **6**

1) The primitive unit cell is one in which only one lattice point at the corner exist.

A) True B) False

2) Each of the angle between the axes of a cubic crystal is of 90°.

A) True B) False

3) A covalent bond is when atoms lose valence shell electrons.

A) True B) False

4) When a voltage is placed across a semiconductor, free electrons move toward the negative voltage.

A) True B) False

5) Germanium is the most widely used semiconductor material because of its stability at high temperatures.

A) True B) False

6) The natural elements carbon, germanium and silicon are semiconductors.

A) True B) False

2. Attempt following :

   a) Ionic polarization. **5**

   b) Periodic zone scheme. **5**

   c) Cooper pair. **4**

3. a) What is meant by reciprocal lattice ? Discuss concept of reciprocal lattice. **8**

   b) Discuss elementary concepts of polycrystalline, noncrystalline and amorphous materials. **6**

4. a) What do you mean by Brillouin zone ? Construct Fermi surfaces in Brillouin zones for two-dimensional lattices. **8**

   b) Explain x-ray scattering from solids including Laue conditions. **6**

5. a) Explain the motion of electron in periodic potential. **8**

   b) Discuss electronic and orientational polarization. **6**

6. a) Give a brief account of experimental determination of band gap. **8**

   b) Explain Meissner effect. **6**

7. a) Derive London equation and show that it accounts for the Meissner effect. **10**

   b) Explain Type-I and Type-II superconductors with example. **4**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2016
(New) (CBCS Pattern)
PHYSICS (Materials Science)
Paper – III : Analog and Digital Electronics

Day and Date : Saturday, 2-4-2016 Max. Marks : 70

Time : 10.30 a.m. to 1.00 p.m.

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

1. a) Select the correct alternative : **8**

1) The Boolean expression B. (A + B) + A can be realized using a minimum number of

a) One AND gate b) Two AND gate

c) One OR gate d) Two OR gate

2) A _____ is similar to a demultiplexer with exception that there is no data input.

a) Decoder b) Encoder c) Multiplexer d) Counter

3) The stack in 8085 μp operates on _____ mode.

a) FIFO b) LIFO c) FILO d) FOFI

4) The 7912 regulator IC provides

a) 5 V b) – 5 V c) 12 V d) – 12 V

5) Which of the following is volatile memory ?

a) RAM b) ROM c) PROM d) EPROM

6) The input impedance of an ideal op-amp is

a) 0 b) infinite c) 1 MΩ d) 100 MΩ

P.T.O.

7) The AND gate is used for Boolean

a) Multiplication b) Addition

c) Complement d) MOD-2 Addition

8) The _____ is used to count the number of clock pulses at the output.

a) Counter b) Flip-flop c) Shift-register d) Encoder

b) State **true** or **false** : **6**

1) If the CMRR of an op-amp is large then its common mode output voltage is small.
2) For 2-bit ripple counter, 3 flip-flops are required.
3) Demultiplexer can be used as data selector.
4) When op-amp is operated in single ended mode, one input is grounded.
5) Flip-Flop can store 1-bit of information.
6) For a.c. analysis of a differential amplifier we use h-parameters.

2. Attempt the following : **14**
   1) Explain the working of 4 : 1 demultiplexer with its truth table.
   2) Explain the voltage follower with neat diagram.
   3) Write a note on astable multivibrator.

3. a) With a neat circuit diagram explain the working of a triangle wave generator. **8**
   b) What is feedback ? Explain the effect of feedback on bandwidth. **6**

4. a) Explain the circuit for a three op-amp instrumentation amplifier and obtain the expression its output voltage for a given input voltage and resistor value. **10**
   b) What is an inverting amplifier ? **4**

5. a) Explain the block and timing diagram of a 4-bit ripple counter in detail. **8**
   b) Convert the following equation into the standard SOP form and write their corresponding minterms.
   $Y = AB + BC + AC$ **6**

6. a) Explain the signals and timing diagram of 8085 with necessary waveforms. **8**
   b) Write an assembly language program to find out the smallest element in an array using 8085 μp instructions. **6**

7. a) With a neat circuit diagram explain the monostable multivibrator using op-amp. **8**
   b) What are tuned amplifiers ? Give a brief account of LC-tuned amplifier. **6**

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Seat No.	

M.Sc. (Part – I) (Semester – I) (New) (CBCS) Examination, 2016
PHYSICS (Materials Science)
Paper – IV : Classical Mechanics

Day and Date : Tuesday, 5-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

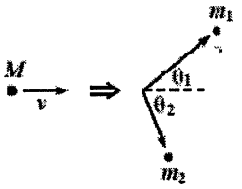
Instructions : *1) Q. **1** and **2** are **compulsory**.*
*2) Answer **any three** questions from Q. **3** to Q. **7**.*
*3) **All** questions carry **equal** marks.*
*4) **Use** of non programmable calculator is **allowed**.*

1. a) Choose correct alternative : **8**

1) Sand drops at a rate of σ kg/s onto a moving conveyor belt. The kinetic energy gained by the sand per unit time is

a) $\frac{mv^2}{2}$ b) $\frac{\sigma v^2}{2}$ c) $\frac{mv^2}{2\sigma}$ d) $\frac{\sigma v^2}{2m}$

2) A mass moving with speed V explodes into two pieces of masses m_1 and m_2, that go off at angles θ_1 and move θ_2 (as shown in adjacent figure). The magnitudes of the momenta of the two pieces are



a) $\frac{p_1}{p_2} = \frac{\sin\theta_1}{\sin\theta}$ b) $\frac{p_1}{p_2} = \frac{\sin\theta_2}{\sin\theta_1}$

c) $\frac{p_1}{p_2} = \frac{\cos\theta_1}{\cos\theta_2}$ d) $\frac{p_1}{p_2} = \frac{\cos\theta_2}{\cos\theta_1}$

3) The degrees of freedom of a dumbbell, whose center of mass is moving on a circular wire, are

a) Four b) Two c) Five d) Three

P.T.O.

4) A satellite revolving in elliptical orbit has v1 and v2 as the maximum and minimum velocities, respectively. The eccentricity 'e' of the orbit is given as

a) v_1/v_2 b) v_2/v_1

c) $(v_1 - v_2) / (v_1 + v_2)$ d) $(v_1 + v_2) / (v_1 - v_2)$

5) The Rutherford scattering cross section has dimensions of

a) area b) time c) length d) volume

6) The Lagrangian L for a charged particle (q) in electromagnetic field is

a) $L = T + q\phi + q(v \cdot A)$ b) $L = T - q\phi + q(v \cdot A)$

c) $L = T + q\phi - q(v \cdot A)$ d) $L = T - q\phi - q(v \cdot A)$

7) The Hamiltonian H for a simple pendulum of mass m and length l is

a) $H = \frac{p_\theta^2}{2ml^2} + mgl(1 - Cos\theta)$ b) $H = \frac{p_\theta^2}{2ml^2} + mg(1 - Cos\theta)$

c) $H = \frac{p_\theta^2}{2ml^2} - mgl(1 - Cos\theta)$ d) $H = -\frac{p_\theta^2}{2ml^2} + mgl(1 - Cos\theta)$

8) Which of the following relationship holds true for the Poisons beckets between Lx, Ly and Lz ?

a) $[L_x, L_y] = -1$ b) $[L_x, L_y] = 1$

c) $[L_x, L_y] = -L_z$ d) $[L_x, L_y] = L_z$

b) **True** or **false.** **6**

1) If a frame is inertial, then any frame moving with constant velocity relative to it, is also an inertial frame of reference.

2) Scleronomic constraints do not explicitly depend on time.

3) The generalized coordinates are always spherical polar coordinates.

4) If the force between the two particles is central, then the torque created by the force is zero.

5) For a parabolic orbit, total energy $E < 0$ and $e = 1$.

6) If the Lagrangian does not depend on time explicitly, then the kinetic energy of the system is constant of motion.

2. Answer in short.
   a) Hamilton's variational principle. **5**
   b) Work energy theorem. **5**
   c) Linear harmonic oscillator. **4**

3. a) Set up Lagrangian for a simple pendulum and obtain the equations of motion. **8**
   b) Show that the shortest distance between any two points is a straight line passing through them. **6**

4. a) State the Kepler's laws of planetary motions. Derive the Kepler's third law. **8**
   b) State and prove the Poison's theorem. **6**

5. a) Define Hamiltonian H and derive the Hamilton's canonical equations of motion. **8**
   b) What are constraints ? What are their types ? Explain with suitable examples. **6**

6. a) Discuss the principle of Least action with proof. **10**
   b) Obtain the differential equation of an orbit. **4**

7. a) Obtain an expression for Rutherfords scattering crossection and interprete. **10**
   b) Show that the transformation $Q = \sqrt{q}\cos 2p$ and $P = \sqrt{q}\sin 2p$ is canonical. Find out the generating function. **4**

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Seat No.	

M.Sc. (Part – I) (Semester – I) (Old) Examination, 2016
(CGPA)
MATERIALS SCIENCE
Paper – I : Mathematical Techniques

Day and Date : Tuesday, 29-3-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

Instructions : *1) Q. No. **1** and Q. No. **2** are **compulsory**.*
*2) Answer **any three** questions from Q. No. **3** to Q. No. **7**.*
*3) Use of **non programable** calculator is allowed.*
*4) **All** questions carry **equal** marks.*

1. 1) Choose the correct alternative. **6**

i) The value of $(\cos(2\pi/3) + i\sin(2\pi/3))^{1/4} =$

a) $\frac{\sqrt{2}}{3} + i\frac{1}{2}$ b) $\frac{\sqrt{3}}{2} - i\frac{1}{2}$ c) $\frac{\sqrt{2}}{3} - \frac{1}{2}$ d) $\frac{\sqrt{3}}{2} + \frac{1}{2}$

ii) The Cauchy Riemmann Equations are given by

a) $u_x = v_y$, $v_x = -u_y$ b) $u_x = v_y$, $v_x = u_y$
c) $-u_x = v_y$, $v_x = u_y$ d) $u_x = -v_y$, $v_x = -u_y$

iii) The general solution of the ordinary differential equation is the soultion in which the number of arbitrary constants equals

a) degree of differential equations
b) order of differential equations
c) no. of terms on LHS of differential equations
d) total no. of terms of the differential equation

iv) The Particular Integral of $(D^3 - 3D^2+4)y = e^{2x}$ is

a) $\frac{x}{6}e^{2x}$ b) $\frac{x^2}{6}e^{2x}$ c) $\frac{x^3}{6}e^{2x}$ d) 0

P.T.O.

v) Inverse Laplace Transform of $\frac{1}{(S-2)^{2+1}}$ =

a) $e^{2t}\cos t$ b) $e^{t}\cos t$ c) $e^{2t}\sin t$ d) $e^{t}\sin t$

vi) Fourier Sine Integral of f(s) is given by

a) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\sin ws.dxds$

b) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\cos ws.dxds$

c) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\sin ws.dwds$

d) $\frac{2}{\pi}\int_0^\infty \sin wx \int_0^\infty f(s)\ \cos ws.dwds$

2) State **true** or **false**. **8**

i) The value of f(z) = u + iv is analytic function then both u and v are Harmonic.

ii) If the vectors are Linearly dependent then one vector can be expressed aslinear combination of others.

iii) Matrix digitalization of symmetric matrix is possible only if it has zero eigen values.

iv) A differential equation is said to be linear if the independent variable is having degree atmost one and dependent variable terms are not in multiplication.

v) $\frac{1}{D^2+16}\sin 4x$ is equal to $-\frac{x}{8}\cos 4x$.

vi) The conditions for expansion of function in a Fourier series are known as Dirichchlet's conditions.

vii) The value of $\frac{(\cos\theta+i\sin\theta)^8}{(\sin\theta+i\cos\theta)^4}$ is $\cos 12\theta + i\sin 12\theta$.

viii) $L\{f(at)\} = \frac{1}{a^2}L\{f(t)\}|_{s/a}$.

2. Write short notes on :

   1) Write a note on Analytic functions. **5**

   2) Write a note on the Particular Integral of a Linear Differential Equations with constant Coefficient. **4**

   3) Write a Fourier Series of f(x) on General Interval. **5**

3. 1) Find Inverse Laplace Transform of $\frac{1}{(s^2+1)^2}$. **6**

   2) Solve $(D^2 - 2D + 4)y = e^x \cos^2 x$. **8**

4. 1) What are Harmonic conjugates ? Find the analytic function f(z) = u + iv given that $v = e^x(x \sin y + y \cos y)$. **10**

   2) Find Laplace of $\frac{1-\cos t}{t}$. **4**

5. 1) Define adjoint of the matrix. Hence find A^{-1} of the matrix using adjoint matrix method for $\begin{pmatrix} 2 & 5 & 3 \\ 3 & 1 & 2 \\ 1 & 2 & 1 \end{pmatrix}$. **8**

   2) Solve $(5+2x)^{\frac{d^2y}{dx^2}} - 6(5+2x)\frac{dy}{dx} + 8y = 6x$. **6**

6. 1) Find Fourier Transform of $f(x) = e^{-x^2/2}$. **8**

   2) Evaluate the integral using Laplace transform method $\int_0^\infty \frac{e^{-2t} - e^{-3t}}{t}\, dt$. **6**

7. 1) Define linear Dependence, Independence and Orthogonality of the vectors. **4**

   2) Find Fourier Series of $f(x) = \frac{1}{2}(\pi - x)$ in $(0, 2\pi)$. **10**

SLR-MH – 480

Seat No.	

M.Sc. – I (Semester – I) Examination, 2016
MATERIALS SCIENCE (Old) (CGPA)
Paper – II : Condensed Matter Physics

Day and Date : Thursday, 31-3-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

***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.*

1. Objectives : **14**

a) Select correct alternatives : **8**

1) The property due to which the resistance of some metal or compound vanishes under certain conditions is
   a) Semiconductivity b) Superconductivity
   c) Curie point d) Magnetostriction

2) Schottky defect generally appears in
   a) NaCl b) CsCl
   c) KCl d) All of these

3) Which of the following statements about amorphous solids is incorrect ?
   a) They melt over a range of temperature
   b) There is no orderly arrangement of particles
   c) They are anisotropic
   d) They are rigid and incompressible

4) When electrons are trapped in the crystal lattice in place of anion vacancy, the defect in the crystal is known as
   a) Frenkel defect b) Schottky defect
   c) F-centre d) Dislocations

5) In a face centered cubic lattice the number of nearest neighbours for a given lattice point are
   a) 6 b) 4
   c) 8 d) 12

P.T.O.

6) A crystal may have one or more planes of Symmetry as well as one or more than one axis of symmetry but it has only
   a) Two centres of symmetry
   b) One centre of symmetry
   c) Four centres of symmetry
   d) No centre of symmetry

7) Ionic solids with Schottky defects contain in their structures
   a) Equal number of cation and anion vacancies
   b) Interstitial anions and anion vacancies
   c) Cation vacancies only
   d) Cation vacancies and interstitial cations

8) If we mix pentavalent impurity in a crystal lattice of germanium, the type of semiconductor formed is
   a) n-type b) p-type
   c) both n and p type d) none of the two

B) State **True** or **False** : **6**

1) Electrons are shared unequally in a polar covalent bond.
   a) True b) False

2) Diamond is a molecular crystal ?
   a) True b) False

3) Sodium chloride, NaCl usually crystallizes in a FCC lattice, 8 ions are in contact with any single Na^+ ion ?
   a) True b) False

4) Percentage of free space in cubic close packed structure and in BC packed structure are 26% and 32% respectively.
   a) True b) False

5) The appearance of colour in solid alkali metal halides is generally due to Schottky defect.
   a) True b) False

6) Number of atoms per unit cell of BCC are 2.
   a) True b) False

2. Write short notes **(any three)** : **14**
   a) Concept of brillouin zones
   b) Interplanar spacing
   c) Complex dielectric constant
   d) Simple cubic structure.

3. a) What is brillouin zone ? Sketch first and second brilloun zones in square lattice. **10**
   b) Define (i) lattice and (ii) crystal structure. **4**

4. a) Derive equation for wave of electron in periodic potential. **8**
   b) Explain the periodic and extended zone schemes. **6**

5. a) Derive an expression for effective mass of an electron. **8**
   b) Derive an expression for dielectric relaxation in alternating fields. **6**

6. a) Derive London equations. **8**
   b) Discuss the static dielectric constant for gases. **6**

7. a) Write about reciprocal lattice. **8**
   b) Distinguish between type I and II superconductors. **6**

SLR-MH – 481

Seat No.	

M.Sc. (Part – I) (Semester – I) (CGPA) (Old) Examination, 2016
MATERIALS SCIENCE
Paper – III : Analog and Digital Electronics

Day and Date : Saturday, 2-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

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

1. a) Select correct alternative : **8**

1) The input offset current equals to _____
   a) average of two base currents
   b) collector current divided by the current gain
   c) difference between two base-emitter voltages
   d) difference between two base currents

2) Instrumentation amplifiers are normally used to measure _____
   a) small differential signal voltages
   b) signals superimposed on a common-mode voltage often much larger than the signal voltage
   c) both of the above
   d) none of the above

3) Minimum frequency at which a crystal will oscillate is known as _____
   a) seventh harmonic b) third harmonic
   c) fundamental d) second harmonic

4) An op-amp integrator has a square-wave input. The output should be _____
   a) a sine wave b) a triangle wave
   c) a square wave d) pure dc

P.T.O.

5) In 8085 _____ interrupt has highest priority.

a) INTR b) TRAP

c) RST 7.5 d) RST 6.5

6) The attenuation of the three-section RC feedback phase-shift oscillator is

a) 1/3 b) 1/9 c) 1/29 d) 1/30

7) Switching regulator efficiencies can be greater than _____ percent.

a) 60 b) 70 c) 80 d) 90

8) Which of the following is correct data for a D latch ?

a) The output toggles if one of the inputs is held HIGH

b) Q output follows the input D when the enable is HIGH

c) Only one of the inputs can be HIGH at a time

d) The output complement follows the input when enabled

b) State whether the following are **True** or **False** : **6**

1) The lead-lag circuit determines the frequency of output for a Wien-bridge oscillator.

2) A switching regulator can be configured as a step-up or a step-down voltage regulator.

3) Operational amplifiers are digital devices.

4) HL pair is known as memory pointer.

5) MVI A, 00 H is two byte instruction.

6) For a Wien-bridge oscillator, resonance occurs when $V_{out}/V_{in} = 1$.

2. Explain **any three** of the following : **14**

1) Multiplexer

2) Encoder

3) Flag register in 8085

4) Adjustable voltage regulator.

3. a) Draw the circuit of triangular wave generator using an op-amp. Explain the operation of circuit drawing output waveform. **8**

   b) Explain the following terms for an op-amp : **6**

      a) Non-inverting input

      b) Frequency response

      c) Slew rate.

4. a) Draw a practical circuit of Summing amplifier. Explain its operation. Derive expression for its gain. **8**

   b) What is common mode signal ? Find common-mode gain of differential amplifier. **6**

5. a) Draw a master slave JK flip flop. Explain its operation. **8**

   b) What are decoders ? Explain 3 to 8 decoder giving its truth table. **6**

6. a) With the help of suitable block diagram explain the bus structure in 8085 microprocessor. **8**

   b) Write a program in 8085 assembly language to add two 8-bit numbers stored in consecutive memory locations. Program must take care of carry. **6**

7. a) Draw the logic circuit using NOR gates to implement the Boolean expression $AB + \overline{B}C$. **8**

   b) Define supply voltage sensitivity. What is meant by a poorly regulated power supply ? **6**

SLR-MH – 483

Seat No.	

M.Sc. (Part – I) (Semester – II) (New CBCS) Examination, 2016
PHYSICS
Materials Science
Paper – V : Statistical Mechanics

Day and Date : Wednesday, 30-3-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

Instructions *: 1) Q.* ***1*** *and Q.* ***2*** *are* ***compulsory****.*
2) Attempt ***any three*** *form Q.* ***3*** *to Q.* ***7****.*
3) Figures to the ***right*** *indicate* ***full*** *marks.*
4) ***Use*** *of nonprogrammable calculator is* ***allowed****.*

1. A) Choose the correct alternative : **8**

1) If r be the ratio of the probability that the two particles are found in the same state to the probability that two particles belongs to different states, then the ratio $r_{MB} : r_{BE} : r_{FD}$ is _____

a) $\frac{1}{2} : 1 : 0$ b) $1 : 0 : 2$ c) $1 : 1 : 2$ d) $1 : \frac{1}{2} : 0$

2) The fluctuation in velocity in MB distribution is related to temperature as _____

a) $\alpha\ T$ b) $\alpha\ T^2$ c) $\alpha\ T^3$ d) $\alpha\ T^{1/2}$

3) The entropy change can be calculated by using the expression $\Delta S = q_{rev}/T$. When water freezes in a glass beaker, choose the correct statement amongst the following

a) ΔS (system) decrease but ΔS (surroundings) remains the same

b) ΔS (system) increases but ΔS (surroundings) decreases

c) ΔS (system) decreases but ΔS (surroundings) increases

d) ΔS (system) decreases and ΔS (surroundings) also decreases

P.T.O.

4) Thermodynamics mainly deals with _____

a) Interrelation of various forms of energy and their transformation from one form to another

b) Energy changes in the processes which depend only on initial and final states of the microscopic systems containing a few molecules

c) How and at what rate these energy transformations are carried out

d) The system in equilibrium state or moving from one equilibrium state to another non-equilibrium state

5) The ratio of two specific heats ($\gamma = C_p/C_v$) of a diatomic gas is _____

a) 1.66 b) 1.40 c) 1.33 d) 1.52

6) The phase space diagram of system is _____

a) Momentum vs. velocity

b) Momentum vs. energy

c) Momentum vs. wave vector

d) Momentum vs. position

7) The extensive property of a thermodynamic system is _____

a) Viscosity b) Surface tension

c) Refractive index d) Heat capacity

8) With rise of temperature, the specific heat of water _____

a) Increases

b) Decreases

c) First decreases to minimum then increases

d) Remains constant

B) Fill in the blanks/State **true** or **false** : **6**

1) _____ ensemble is related to thermal equilibrium of system.

2) Plank's radiation law can be derived by using _____ Statistics.

3) Fermi energy gives the value of energy in F.D. system upto which all the energy states _____

4) B.E. statistics is applicable to photons and symmetric particles. (True/False).

5) The partition function represents the number of thermally accessible energy levels at a given temperature. (True/False).

6) Equipartition theorem is a classical theorem that states that every degree of freedom for motion has an energy of $\frac{1}{2}k_BT$. (True/False).

2. Attempt the following : **14**

a) Derive mean energy of classical one dimensional harmonic oscillator. **5**

b) What is phase space ? **5**

c) Prove that, $N = kT\{[\partial /nZ]/[\partial \mu]\}$; where μ is the chemical potential. **4**

3. Answer the following :

a) Discuss the condition for ideal Bose gas. **8**

b) Establish the relations : $E = \{[\partial(\beta F)]/[\partial \beta]\}_v$. **6**

4. Answer the following :

a) Show that the Sackur-Tetrode equation, may be written in the form :

$$S = NK\{-/np + \left(\frac{5}{2}\right)/nT + \left(\frac{3}{2}\right)/n\left(\frac{2m\pi}{h^2}\right) + \left(\frac{5}{2}\right)(/nk + 1)\}$$

where p is the pressure of the ideal gas. **10**

b) Write a short note on Bose-Einstein's condensation. **4**

5. Answer the following :

   a) Prove, in quantum statistical mechanics that, **10**

   $$\left\langle E^2 \right\rangle - \left\langle E \right\rangle^2 = kT^2 C_v$$

   b) Write a short note on Ensembles. **4**

6. Answer the following :

   a) Show that an average energy of a single partied of ideal Femi gas is 3/5 the Femi energy of a system. **10**

   b) Write down Langevin's suggestion on force related to Brownian motion of particles. **4**

7. Answer the following :

   a) Verify Liouville's theorem in the case of the motion of three particles in a constant gravitation alfield. **8**

   b) Discuss the conditions under which two phases remain in equilibrium with each other. **6**

SLR-MH – 484

Seat No.	

M.Sc. (Part – I) (Semester – II) (New) (CBCS)Examination, 2016
PHYSICS (Materials Science)
Paper – VI : Quantum Mechanics

Day and Date : Friday, 1-4-2016 Total Marks : 70

Time : 10.30 a.m. to 1.00 p.m.

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

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

1) Consider the states, $|\psi_1\rangle = \frac{1}{\sqrt{6}}|1\rangle + \frac{1}{\sqrt{2}}|0\rangle + \frac{1}{\sqrt{3}}|-1\rangle$ and

$|\psi_2\rangle = -\frac{1}{\sqrt{6}}|1\rangle + a|0\rangle - \frac{1}{\sqrt{3}}|-1\rangle$ then value of a for which these states are orthogonal is _____

a) $\frac{1}{\sqrt{2}}$ b) $\sqrt{2}$ c) $-\frac{1}{\sqrt{2}}$ d) $-\sqrt{2}$

2) For the Gaussian wave function $\psi(x) = Ne^{-x^2/2\sigma^2}$ where $-\infty < x < +\infty$, then value of N is _____

a) $\pi\sigma^2$ b) $\frac{1}{\sqrt{\pi\sigma^2}}$ c) $\sqrt{\pi\sigma^2}$ d) $\frac{1}{\pi\sigma^2}$

3) If a proton and electron have a same de-Brogalie wavelength of $3\,\mathring{A}$ then _____

a) Both have same kinetic energy
b) Both have same velocity
c) Both have same momentum
d) Kinetic energy of an electron is less than that of a proton

P.T.O.

4) If the wave function for a particle moving in x direction is $\psi(x) = A\, e^{ikx}$, where $0 < x < L$, then the Normalization Constant A is _____

a) $\frac{\sqrt{2}}{\sqrt{L}}$ b) $\frac{1}{\sqrt{L}}$ c) $\frac{\sqrt{2}}{\sqrt{x}}$ d) $\frac{1}{\sqrt{x}}$

5) A particle of mass m is confined in the ground state of a one dimensional box extending from x = –2L to x = +2L. The wave function is $\psi(x) = \psi_0 \cos\left(\frac{\pi x}{4L}\right)$ where ψ_0 is constant. The energy corresponding to this state is _____

a) $\frac{\hbar^2\pi^2}{2mL^2}$ b) $\frac{\hbar^2\pi^2}{4mL^2}$ c) $\frac{\hbar^2\pi^2}{8mL^2}$ d) $\frac{\hbar^2\pi^2}{32mL^2}$

6) The ground state energy of the hydrogen atom is –13.6 eV. The energy of the second excited state is _____

a) –0.5 eV b) –1.5 eV c) –4.5 eV d) –6.8 eV

7) The graph of probability density versus r for a Hydrogen atom in state n = 2 shows _____ peaks.

a) none b) one c) two d) three

8) The average nuclear charge for an electron in an atom _____ for larger values of 'l'.

a) increases b) decreases
c) first increases and then decreases d) none of these

9) The linear combination of atomic orbitals gives _____ energies and molecular orbital.

a) Accurate b) Approximate
c) Depending on Hamiltonian d) None of these

10) The electrons in K shell have _____ spins.

a) parallel b) antiparallel c) no d) none of these

11) Quantum mechanical Harmonic Oscillator approaches the classical oscillator for _____

a) small values of quantum number n
b) large values of quantum number n
c) independent of n
d) none of these

12) The force constant k is given as _____
a) $m\omega^2$ b) $m^2\omega^2$ c) $m^2\omega$ d) $m\omega^3$

13) Which of the following matrices is Hermitian ?
a) $\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$ b) $\begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix}$ c) $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ d) $\begin{bmatrix} 0 & i \\ -i & 0 \end{bmatrix}$

14) Eigen values of an unitary operator are
a) real b) imaginary c) ± 1 d) zero

2. Write short answer of the following :
a) With proper operators, derive Schrödinger's equation. Separate the time dependent form of the equation. **5**
b) Taking into consideration all interactions, derive an expression for the Hamiltonian of many electron atom. **5**
c) Show that the eigen functions ψ_1 and ψ_2 of a Hermitian operator having eigen values m and n are orthogonal to each other. **4**

3. a) Solve the Schrödinger equation for the system of particle in a box and obtain the expression for energy eigen value and normalized wave function. **10**
b) Which parameters affect the energy eigen value of a particle in a box ? **4**

4. a) Discuss the Harmonic Oscillator problem in one dimension. Solve the Schrödinger equation and obtain the energy and normalized wave functions. **10**
b) Show the graphs of first few wave functions and probability densities of harmonic oscillator. **4**

5. a) Set up a Schrodinger equation in spherical polar co-ordinates for hydrogen atom. **6**
b) Solve the (H) part of the above equation. Write the normalized eigen functions for (H) part. **8**

6. a) What is spin orbital ? **2**
b) Using Pauli's principle define the wave function ψ for two electron atom. **4**
c) Generalize this equation for the system of n electrons and explain the slater determinant. **8**

7. a) Give details of the LCAO approximation and hence explain the secular equation. **10**
b) Explain the Hamiltonian of hydrogen molecule. **4**

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SLR-MH – 485

Seat No.	

M.Sc. – I (Semester – II) (New-CBCS) Examination, 2016
PHYSICS (Mat.Science)
Paper – VII : Electrodynamics

Day and Date : Monday, 4-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

***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 non programmable calculator is **allowed**.*

1. Objective questions : **14**

a) Choose correct alternatives : **8**

1) Which one of the fundamental equation was modified by Maxwell to form the basis of electromagnetic theory ?
   a) Gauss law of electrostatic
   b) Gauss law of magnetostatic
   c) Faraday law
   d) Ampere law

2) A magnetic field strength of $H_o \mu A/m$ is measured at a point $\theta = \pi/2$, d km from four antennas in air-a Hertzian dipole of length $\lambda/2$, a half wave dipole, a quarter wave monopole and a 5 turn loop antenna of radius $\lambda/20$. The maximum power transmitted is by
   a) Quarter wave monopole b) A half wave dipole
   c) Hertzian dipole d) Loop Antenna

3) The displacement current J_D is
   a) Hypothetical
   b) Dominant at low frequencies
   c) Dominant at high frequencies
   d) Dominant in time independent case

4) For a circular loop of constant surface area, the Faraday law gives $\nabla \times E = -dB/dt$. The electric field in this case is
   a) Conservative
   b) Equal to ∇V
   c) Quasi-conservative
   d) Non-conservative

5) Maxwell inserted the expression for displacement current J_D in Ampere's law to satisfy
   a) Ampere's law for time varying case
   b) Faraday's law
   c) Gauss law
   d) Equation of continuity

6) The effective length of an antenna depends on
   a) The current distribution
   b) Angle of radiation
   c) The wavelength of radiation
   d) Area of cross section

7) Which of the following circuit element will oppose the change in circuit current ?
   a) Capacitor b) Resistor
   c) Inductor d) All of the above

8) Electromagnetic wave is incident on a dielectric conductor interface at a certain angle θ. The non zero electric field E will be always at an angle
   a) 0° b) 45°
   c) 60° d) 90°

B) **True** or **False** : **6**

1) Lorentz condition is invariant in those gauge functions which are the solutions of homogeneous wave equations.

2) The incident, reflected, refracted waves and also the normal to the interface do not lie in the same plane.

3) The normal component of electric displacement is not continuous across the interface and changes by an amount equal to the free surface density of charge at the interface.

4) Even if Poynting vector is zero, some electromagnetic energy can flow across a closed surface.

5) Maxwell's equations are viewed as a unification of magnetic and electric forces.

6) The field vectors E and H are attenuate exponentially as the wave penetrates the conducting medium.

2. Write short answers : **14**

a) State and explain the Faraday's laws of electromagnetic induction. **5**

b) Write the Maxwell's equation for free space in differential form. **5**

c) Write Maxwell's equation for a moving media. **4**

3. a) Prove the Poynting's theorem relating to the flow of energy at a point in space in an electromagnetic field. **8**

b) A plane electromagnetic wave is incident on a dielectric surface. Find the amplitudes of the reflected and refracted wave and discuss their phase change. **6**

4. a) Obtain Lorentz condition which exhibits interrelationship of electromagnetic potentials. **8**

b) Obtain Wave equations in terms of electromagnetic potentials. **6**

5. a) What is the physical meaning of radiation resistance ? Obtain its value for a dipole antenna. Justify the selection of $\lambda/2$ antenna on this basis. **8**

b) Find out the power radiated by an oscillating electric dipole and describe its angular distribution. **6**

6. a) Establish the boundary conditions for electromagnetic field. **8**

b) Write a note on Gauge transformations. **6**

7. a) Explain the propagation of EM waves in a conducting media. **8**

b) Show that the electrostatic energy density is equal to magnetostatic energy density. **6**

SLR-MH – 486

Seat No.	

M.Sc. – I (Semester – II) Examination, 2016
PHYSICS (Materials Science) (New CBCS)
Paper – VIII : Analytical Techniques

Day and Date : Wednesday, 6-4-2016 Total Marks : 70

Time : 10.30 a.m. to 1.00 p.m.

Instructions : *1) Attempt **five** questions.*
*2) Q. **(1)** and **(2)** are **compulsory**.*
*3) Attempt **any three** from Q. **3** to Q. **7.***
*4) **Use** of nonprogrammable calculator is **allowed**.*

1. A) Choose the correct alternative. **8**

1) X-ray diffraction fails to detect the presence of substances
   a) Containing a magnetic field
   b) Containing a high concentration of carbon
   c) Comprising less than 5 percent of a mixture
   d) Comprising elements with two or more isotopes

2) What type of technique is FTIR spectroscopy ?
   a) A dispersive technique b) An emission technique
   c) An absorbance technique d) A UV-Vis technique

3) The relationship between transmittance (T) and absorbance (A) is
   a) $T = 10^{-A}$ b) $T = 1/A$
   c) $A = \ln (T)$ d) $A = 10 \log (T)$

4) In its usual mode, the scanning electron microscope (SEM) has a magnification that ranges from
   a) 10x to 10,000x b) 100x to 10,000x
   c) 10x to 100,000x d) 1x to 100x

5) Which of the following is not a part of the optical system of a compound microscope ?
   a) Condenser b) Fine adjustment
   c) Ocular lens d) Illuminator

6) The major attractions of the scanning electron microscope (SEM) include all of the following except its
   a) Great depth of focus b) High magnification
   c) Ability to polarize light d) High resolution

7) A series of 3 coloured glass plates of equal thickness are placed in a light beam. Each sheet absorbs one quarter of the light incident upon it. What is the intensity of the light transmitted by the third glass plate ?
   a) 1.56% b) 42.19% c) 56.25% d) 75.00%

8) The magnification power of transmission electron microscope
   a) 250000 b) 450000 c) 320000 d) 150000

B) State **true/false**. **6**

1) The energy of X-rays depend upon the acceleration voltage.

2) The characteristic X-rays have multiply wavelength than white radiation.

3) When a molecule absorbs infrared radiation it vibrates faster ?

4) The intensity of the X- rays depends on atomic weight of materials.

5) Energy of K_α radiation is lower than K_β radiation.

6) The reflection of visible light takes place from atoms of surface layers.

2. Attempt the following. **14**

1) How to calculate average particle size using X-ray diffractograms ? **5**

2) Explain absorption of common functional groups in Infra-red spectroscopy (IR) spectroscopy. **4**

3) Draw and explain chemical shift in X-ray photoelectron spectroscopy (XPS). **5**

3. A) Determine the lattice parameters and crystal structure of a cubic system. **10**

   B) Explain how to calculate intensity for cubic system. **4**

4. A) Calculate the absorption maximum of dienes and polyene. **10**

   B) Give the applications of Infra-red spectroscopy. **4**

5. A) Explain the working principle of Fourier-Transform Infra Red (FTIR) Spectroscopy. **10**

   B) How to interpret and analyze the data using Fourier-Transform Infra Red (FTIR) Spectroscopy ? **4**

6. A) Discuss the working principle of Raman Spectroscopy. What are Stoke's and antistoke's lines. **10**

   B) Compare FTIR and Raman spectroscopies. **4**

7. A) Write in details the working of X-ray Photoelectron Spectroscopy (XPS). **10**

   B) Explain the depth-profiling using X-ray Photoelectron Spectroscopy (XPS). **4**

SLR-MH – 488

Seat No.	

M.Sc. (Part – I) (Semester – II) (Old CGPA) Examination, 2016
MATERIALS SCIENCE
Paper – VI : Quantum Mechanics

Day and Date : Friday, 1-4-2016 Max. Marks : 70

Time : 10.30 a.m. to 1.00 p.m.

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

1. A) Choose the correct alternative : **6**

i) The de Brogalie wavelength of a charge q, accelerated through a potential difference of V volts is

a) $\lambda = \frac{h}{\sqrt{mqV}}$ b) $\lambda = \frac{hm}{\sqrt{qV}}$ c) $\lambda = \frac{h}{\sqrt{2mqV}}$ d) $\lambda = \frac{h}{mqV}$

ii) For a particle moving in x direction and having a wave function ψ = A sin (kx – wt), its energy is

a) $\frac{k^2\hbar^2}{2m}$ b) $\frac{k\hbar}{2m}$ c) $\frac{\hbar^2k^2}{m}$ d) $m^2\hbar^2$

iii) The uncertainty product $\Delta x \,.\, \Delta p$ for a harmonic oscillator is

a) $\frac{h}{2\pi}$ b) $\frac{h}{4\pi}$ c) $\frac{nh}{2\pi}$ d) $(n+1)\frac{h}{2\pi}$

iv) The operator $\frac{d^2}{dx^2}$ has the eigen value corresponding to an eigen function sin(α x) as

a) 4 b) 2 c) 2i d) – 2i

P.T.O.

v) The zero point energy of an electron in a one dimensional box of length 'a' is

a) $\frac{h^2}{8m_e a^2}$ b) $\frac{h^2}{4\pi m_e a^2}$

c) $\frac{h^2}{4m_e a^2}$ d) $\frac{h^2}{8m_e a^2}$

vi) The energy of hydrogen like atoms depends on

a) n^2 b) $\frac{1}{n^2}$ c) $\frac{1}{n}$ d) n^3

B) Write whether following statements are **True** or **False** : **4**

vii) The quantity $\frac{\hbar^2}{me^2}$ has the dimension of length.

viii) Eigen values of the Hermitian operator are not real.

ix) The eigen value of the first excited state of the one dimensional harmonic oscillator is $2\ \hbar w$.

x) The 1s orbital is the lowest energy orbital of the hydrogen.

C) Fill up the blanks : **4**

xi) The system of H_2^+ is composed to two protons and _____

xii) Eigen functions of Harmonic oscillator are _____ polynomials.

xiii) The operator which represents energy in quantum mechanics is _____

xiv) Long form of LCAO is _____

2. Answer in brief : **14**

a) Explain the Dirac Delta function and its properties.

b) Prove that if $\underline{\Psi}_1$ and ψ_2 are the eigen functions of the Hermitian operator with eigen values a_1 and a_2, then these eigen functions are orthogonal to each other.

c) Show that the total wave function of a many electron system is given by a product of one electron functions and not by a sum.

3. a) Set up Schrödinger equation for one dimensional box. Obtain energy eigen values and zero point energy. **6**

   b) Obtain the normalized eigen function for the particle in a box and also discuss orthogonality. **8**

4. a) Using the Schrödinger equation, obtain the eigen functions and energy levels for a one dimensional harmonic oscillator. **10**

   b) Show that $H_3(\xi) = 8\xi^3 - 12\xi$, where $H_3(\xi)$ is Hermite polynomial. **4**

5. a) Solve the Radial wave eqn. of hydrogen like atom. Discuss the r dependent part of the wave eqn. **10**

   b) State and explain normalized wave function for $R_{nl}(r)$. **4**

6. a) The Hamiltorian of Helium is given as $H = H_1 + H_2 + \frac{1}{r_{12}}$, where Hi = $-\frac{1}{2}\nabla_i^2 - \frac{2}{ri}$

   use the wave function. $\psi_0 = \frac{1}{\sqrt{2}}[1s(1)1s(2)][\alpha(1)\beta(2) - \beta(1)\alpha(2)]$ where, all symbols have usual meanings in the context of Helium atom. **10**

   b) Obtain the ground state energy of Helium. **4**

7. a) Within the framework of LCAO approximation evaluate the energy of a H_2 molecule. Define various integrals and the observed potential energy curves. **10**

   b) Write a note on Slaters rule. **4**

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SLR-MH – 490

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2016
MATERIALS SCIENCE
Paper – VIII : Analytical Techniques (Old CGPA)

Day and Date : Wednesday, 6-4-2016 Total Marks : 70
Time :10.30 a.m. to 1.00 p.m.

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

1. a) Select correct alternatives : **8**

i) The conditions of monoclinic crystal system are _____

a) $a = b = c, \alpha = \beta = \gamma = 90°$ b) $a \neq b \neq c, \alpha = \beta = \gamma \neq 90°$

c) $a \neq b \neq c, \alpha = \beta = \gamma = 90°$ d) $a = b = c, \alpha = \beta = \gamma \neq 90°$

ii) The conditions of triclinic crystal system are _____

a) $a = b = c, \alpha = \beta = \gamma = 90°$ b) $a = b \neq c, \alpha = \beta = \gamma = 90°$

c) $a \neq b \neq c, \alpha \neq \beta \neq \gamma = 90°$ d) $a = b = c, \alpha = \beta = \gamma \neq 90°$

iii) The absorption in the molecule shifts towards higher wavelength region is known as _____

a) Bathochromic shift b) Hypochromic shift

c) Hyperchromic shift d) Hypsochromic shift

iv) The minimum amount of energy is required for _____ transition.

a) $\sigma - \sigma^*$ b) $n - \sigma^*$ c) $\pi - \pi^*$ d) $n - \pi^*$

v) The wavelength region of ultraviolet radiation is _____

a) 200-400 nm b) 400-800 nm c) 200-800 nm d) 100-200 nm

vi) X-ray photoelectron spectroscopy is used for _____ analysis.

a) Depth profiling b) Oxidation state analysis

c) Both a) and b) d) None of these

P.T.O.

vii) The no. of vibrational modes for a nonlinear molecule is _____

a) 3n – 5 b) 3n – 6 c) 4 d) 30

viii) _____ are of shorter wavelength than that of the wavelength of exciting radiation.

a) Stokes lines b) Anti-stokes lines

c) Raman lines d) All of these

b) State **true** or **false** : **6**

i) The energy of the scattered radiation is more than the incident radiation for the stokes line.

ii) Deuterium lamp is a source of visible radiation.

iii) The no. of vibrational modes for CO_2 molecule is 4.

iv) The bonds having asymmetric stretching are IR active.

v) The UV-VIS spectroscopy is used for determination of extent of conjugation present in the molecule.

vi) Lamberts law is not used in the determination of concentration of solution.

2. Write short notes :

a) Modes of vibration in IR spectroscopy. **5**

b) Transitions involved in UV-VIS spectroscopy. **5**

c) Quantification and depth profiling in XPS. **4**

3. a) Describe in detail the X-ray powder diffraction method. **10**

b) Write a note on basic crystal systems. **4**

4. a) Give basic principle and instrumentation of FTIR spectroscopy. **10**

b) Discuss the principle of Raman spectroscopy. **4**

5. a) Discuss the principle and operation of X-ray photoelectron spectroscopy. **10**

b) Write a note on absorption and intensity shifts in UV-VIS spectroscopy. **4**

6. a) Give the details of sampling techniques in IR spectroscopy. **10**

b) Write a note on attenuated total reflection. **4**

7. a) Give the principle and instrumentation configuration of UV-VIS spectroscopy. **10**

b) Give the method to determine crystallite size using XRD pattern. **4**

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SLR-MH – 491

Seat No.	

M.Sc. – II (Semester – III) (New) (CGPA) Examination, 2016
MATERIALS SCIENCE
Paper – IX : Semiconductor Devices

Day and Date : Tuesday, 29-3-2016 Max. Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Attempt **five** questions.*
*2) Q. **1** and Q. **2** are **compulsory**.*
*3) Solve **any three** from Q. **3** – Q. **7**.*
*4) **Use** of non-programmable calculator is **allowed**.*

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

1) The safety factor in power diode is

a) $\frac{t_a}{t_b}$ b) $\frac{t_b}{t_a}$ c) $t_a . t_b$ d) $\frac{1}{t_a . t_b}$

2) CMOSFET uses only _____ type MOSFET's.

a) Enhancement b) Depletion c) Both a) and b) d) IGBT

3) In a triac, the most sensitive mode of operation is the mode that requires _____ gating signal.

a) least b) maximum c) zero d) intermediate

4) When a MOS-diode is biased with a large voltage (V > 0), _____ crosses _____ to establish an inversion.

a) E_i, E_c b) E_i, E_v c) E_F, E_i d) E_i, E_F

5) The ground state degeneracy for an acceptor is

a) 6 b) 9 c) 1 d) 4

6) Modern MOSFET's are fabricated on a _____ Si.

a) < 111 > b) < 110 > c) < 101 > d) < 100 >

7) The wavelength (λ) and photon energy ($h\nu$) are related as

a) $\lambda = h\upsilon$ b) $\lambda = \frac{1.24}{h\upsilon}$ c) $\lambda = \frac{h\upsilon}{1.24}$ d) $\lambda = 1.24.h\upsilon$

P.T.O.

8) In NMOS technology _____ MOSFET are used.

a) Both N-channel b) Both P-channel

c) N and P channels d) Channel not required

9) The figure of merit of tunnel diode is

a) I_p b) I_v c) $\frac{I_p}{I_v}$ d) $\frac{I_v}{I_p}$

10) For a LED, the dominating operating process is

a) spontaneous emission b) stimulated emission

c) absorption d) reflection

11) MCT is a combination of _____ and _____

a) Thyristor and a transistor b) Thyristor and a diode

c) Thyristor and a FET d) Thyristor and a MOSFET

12) For a pocket calculator or wrist watch, which of the following device can be wired as a circuit element ?

a) BJT b) Power diode

c) SIT d) CMOS

13) The maximum human eye sensitivity is at

a) 0.490 μm b) 0.555 μm

c) 0.520 μm d) 0.700 μm

14) Γ point is a point where the bottom of the conduction band is at

a) $K = +\ \pi$ b) $K = +\ 2\pi$

c) $K = 3\pi$ d) $K = 0$

2. Answer the following : **14**

a) CMOS inverter action

b) $\frac{dv}{dt}$ rating

c) PUT

3. a) Discuss the reverse recovery characteristic of a diode. **10**

   b) Two transistor analogy of a SCR. Explain. **4**

4. a) Explain how IGBT behaves as a MOSFET and a BJT. **10**

   b) Write a note on fast recovery diode. **4**

5. a) Discuss the hydraulic system for charge storage mechanism. **10**

   b) Find the characteristic impedance of a nearly loss-less line (R-very small) that has unit length inductance of 10 nH and a unit length capacitance of 4pF. **4**

6. a) Discuss and compare transferred Electron effect in GaAs and I_n P. **10**

   b) What is velocity-field characteristic ? **4**

7. Write notes on (**any three**) : **14**

   a) IR – LED

   b) SCR

   c) CCD

   d) Interface traps can follow both gate bias and the ac signal at low frequencies. Comment.

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SLR-MH – 492

Seat No.	

M.Sc. – II (Semester – III) Examination, 2016
(New) (CGPA)
MATERIALS SCIENCE
Paper – X : Instrumentation

Day and Date : Thursday, 31-3-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

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 non programmable calculator is* ***allowed****.*

1. Objective questions. **14**

a) Select correct alternatives. **8**

i) In strain gauges, which of the following varies in accordance with the input signal

a) resistance b) capacitance
c) inductance d) none of the above

ii) Piezo-electric crystal can be used as a transducer to measure

a) pressure b) acidity
c) speed d) distance

iii) In an OPAMP logarithmic amplifier, the output voltage forms a logarithmic function of the

a) reference voltage b) input voltage
c) peak voltage d) rms voltage

iv) In lock-in-amplifier, a phase sensitive detector circuit is basically a

a) comparator b) mixer
c) rectifier d) amplifier

P.T.O.

v) Study of energy distribution of a signal as a function of frequency can be done by

a) frequency meter b) timer

c) spectrum analyzer d) oscilloscope

vi) A sample and hold circuit is normally placed between

a) MUX and DEMUX b) Source and DAC

c) Source and ADC d) Transducer and amplifier

vii) Thickness can be measured with

a) Thermistor b) Thermocouple

c) Strain gauge d) LVDT

viii) Q-meter is used for the measurement of

a) quotient factor b) force

c) pressure d) quality factor

b) State **true** or **false** : **6**

i) In microphone, the capacitance varies in accordance with the input.

ii) Displacement can not be measured with LVDT.

iii) Thermistor is a positive temperature coefficient device.

iv) In SMPS, FETs are used as switching devices.

v) Potentiometers can be used to vary resistance of circuit.

vi) ADCs and multiplexers are used in multichannel data acquisition system.

2. Write short notes. **14**

a) Classify the transducers according to the principle of operation. **5**

b) Explain the working of a RMS converter. **5**

c) Explain the measurement of R, L and C using bridge circuit. **4**

3. a) With neat diagram, explain the working of LVDT. **10**

b) Write a note on chemical sensors. **4**

4. a) With a neat diagram, explain the working of an instrumentation amplifier. State its basic characteristics. **10**

   b) Write a note on proportional controller. **4**

5. a) Draw the diagram of a lock-in amplifier and explain its functioning. **10**

   b) Write a note on proximity detector. **4**

6. a) Describe with necessary diagram, the operation of a digital multimeter. **10**

   b) What is PID controller ? Explain. **4**

7. a) Describe with examples, the standard interface systems. **10**

   b) Write a note on dynamic signal filtering. **4**

SLR-MH – 493

Seat No.	

M.Sc. Part – II (Semester – III) Examination, 2016
PHYSICS MATERIALS SCIENCE (New) (CGPA)
Paper – XI : Elements of Material Science

Day and Date : Saturday, 2-4-2016 Total Marks : 70

Time :2.30 p.m. to 5.00 p.m.

***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 non programmable calculator is **allowed**.*

1. Objective questions. **14**

a) Select correct alternatives. **8**

1) The life time of metastable state in comparison to excited state is _____

a) Smaller b) Greater c) Equal d) All of the above

2) The space lattices with two lattice parameters belong to the _____ crystal systems.

a) Tetragonal b) Rhombohedral c) Hexagonal d) All of the above

3) Thermal conductivity in polymers increases with _____

a) Increase in crystallinity b) Decrease in crystallinity

c) Either d) None

4) The Beer-Lambert law is the linear relationship between

a) Absorption and wavelength

b) Voltage and analyte concentration

c) Absorption and concentration of an absorbing species

d) Absorptivity coefficient and path-length

5) In an extrinsic semiconductor, in the region where mobility variation with temperature is evident, the slope of log (conductivity) vs I/T plot is _____

a) Positive b) Negative c) Zero d) Infinity

P.T.O.

6) Electro-luminescence occurs in _____
   a) Electrical conductors b) Electrical insulators
   c) p-n junctions d) All
7) Hydrogen bonds are stronger than _____
   a) van der Waals bonds b) Ionic bonds
   c) Metallic bonds d) Covalent bonds
8) _____ is not a characteristic property of ceramic material.
   a) High temperature stability b) High mechanical strength
   c) Low elongation d) Low hardness

b) Fill in the gaps. **6**

a) _____ semiconductor material is used in the construction of LED.

b) A _____ is a light-sensitive device whose number of free electrons generated is proportional to the intensity of the incident light.

c) Polymers have thermal conductivities in the range _____ than I.

d) The majority charge carriers in p-type Ge are _____

e) Poole-Frenkel effect is present in _____

f) Fermi level for a p-type semiconductor lies _____

2. Write short notes on : **14**

1) Types of excitons in semiconductors. **5**

2) Classification of engineering materials. **5**

3) a) Electroluminiscence b) Cathodoluminiscence **4**

3. a) Describe the metal-semiconductor band diagram for the junction at equilibrium for a p-type semiconductor and metal having small work function. Show the effect for forward and reverse bias on the junction with the help of typical I - V characteristics. **8**

b) Define ceramic, give its classification and explain each class with applications in brief ? **6**

4. a) Explain the polymerization mechanism and degree of polymerization. **8**

b) Explain the different energy bands of solids. **6**

5. a) What is the photoconductivity ? Explain its characteristics. Give the basic working principle of LASER. **8**

   b) Describe the factors affecting the properties of polymers : molecular structure and physical characteristics of polymers. **6**

6. a) What is luminescence ? Give its classification with application for each. **8**

   b) Explain in details the crystal structure and bonding in Ge. **6**

7. a) Describe the band theory in solids. **10**

   b) Write a note on Light absorption in semiconductors. **4**

SLR-MH – 494

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2016
MATERIALS SCIENCE
Paper No. – XII : Dielectric and Ferroelectric Materials (New) (CGPA)

Day and Date : Tuesday, 5-4-2016 Max. Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

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.*

1. Objective questions. **14**

a) Select correct alternatives : **8**

1) According to wave theory, the velocity of em waves in any dielectric medium is

a) $c = \frac{1}{\mu_0 \varepsilon}$ b) $c = \frac{1}{\mu \varepsilon}$

c) $c = \mu\varepsilon$ d) $c = \frac{1}{\sqrt{\mu\varepsilon}}$

2) The factor responsible for spontaneous polarization is

a) Free electrons b) Atoms
c) Permanent dipoles d) None of these

3) Piezoelectric effect is the production of electricity by

a) Chemical effect b) Pressure
c) Varying field d) Temperature

4) The relation between temperature 'T' and entropy 'S' defines the heat capacity Q through the relation

a) $S = -\frac{Q}{T}$ b) $S = \frac{Q}{T^2}$

c) $S = -\frac{Q}{T^2}$ d) $S = \frac{Q}{T}$

P.T.O.

5) Barium titanate ($BaTiO_3$) becomes symmetric and stable above _____°C.
   a) 120 b) – 95
   c) 5 d) 30

6) Which materials exhibit hysteresis curve in the polarization when an electric field is applied ?
   a) Dielectric b) Antiferroelectric
   c) Ferroelectric d) All of these

7) The band gap of silicon materials is
   a) 0.4 eV b) 0.7 eV
   c) 1.1 eV d) 1.4 eV

8) Above the Curie temperature the ferroelectric material becomes
   a) Antiferroelectric b) Piezoelectric
   c) Paraelectric d) Dielectric

b) State **true** or **false** : **6**

1) The number of silicon atoms per unit volume is 5×10^{22} atoms/cm^3.
2) Both the thermal velocity and drift velocity are temperature independent.
3) All pyroelectrics possess piezoelectric effects, but not all are ferroelectric.
4) Ferroelectric materials exhibit ferroelectric properties only at temperatures below T_c because they are not polar.
5) The spontaneous polarization for ferroelectric material is non-zero above curie temperature.
6) Polarization in a dielectric on application of electric field is the displacement of opposite charge centers.

2. Write short notes : **14**

a) State and prove Ampere's law. **5**

b) Write a note on Faraday effect in Magneto-optic effect. **5**

c) Enlist type of dielectric polarization. **4**

3. a) What is electro-optic effect ? Discuss in detail the linear electro – optic effect. **10**

b) Write a note on acousto-optic effect. **4**

4. a) Discuss in detail the thermodynamic theory for ferroelectrics. **10**

b) Discuss any one application of ferroelectric material. **4**

5. a) Discuss the electric field distribution in two media separated by a boundary, for the following cases :
   i) Tangential field parallel to a plane boundary
   ii) Normal field $\perp$lar to a plane boundary
   iii) Inclined field with an incident angle θ 1 incident on a plane boundary.
   iv) A sphere of radius 'r' having permittivity $\in_2$ in a medium having permittivity $\in_1$ with $\in_2 > \in_1$. **10**

   b) What are NTC materials ? **4**

6. a) Explain in detail the relation between the dielectric relaxation and chemical structure. **10**

   b) Write a note on polar and non-polar dielectrics. **4**

7. a) Sketch and explain the Gibb's free-energy (G-Go) as a function of polarization at transition temperature TC and at temperatures just above and below, TC, for :
   i) First order transition and
   ii) Second-order transition. **10**

   b) Illustrate the graphical variation of different type of polarisation with time under step function electric field. **4**

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SLR-MH – 495

Seat No.	

M.Sc. – II (Semester – III) Examination, 2016
PHYSICS (Materials Science) (Old – CGPA)
Paper – IX : Semiconductor Devices

Day and Date : Tuesday, 29-3-2016 Max. Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

***Instructions** : 1) Attempt **five** questions.*

*2) Questions **1** and **2** are **compulsory**.*

*3) Attempt **any 3** questions from Q. **3** to Q. **7**.*

*4) **Use** of nonprogrammable calculators is **allowed**.*

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

1) In the saturation mode, the base to collector junction of a transistor is _____ biased

a) reverse b) forward c) both a and b d) requires no bias

2) Virtual channel exists in _____ power MOSFETS.

a) n-channel depletion b) p-channel depletion

c) n-channel enhancement d) both a and b

3) In a MIS diode system, the capacitance due to _____ is voltage independent.

a) semiconductor b) insulatory

c) metal d) space charge

4) Zero surface potential means _____ condition.

a) flat band b) accumulation c) depletion d) inversion

5) A CCD is an array of

a) closely spaced BJT's b) closely spaced FET's

c) closely spaced thyristors d) closely spaced MOS diodes

P.T.O.

6) The figure of merit of a tunnel diode is given as

a) I_p b) I_v c) I_p/I_v d) I_v/I_p

7) _____ in GaAs makes it feasible for ultra-high-speed CCD's.

a) high electron mobility b) low electron mobility
c) high hole mobility d) high electron concentration

8) The major limitation of a surface channel CCD is

a) Interface trap effect b) bias voltage effect
c) fringing field effect d) intermittent effect

9) TFT is fabricated on _____ substrates.

a) metal b) insulator c) silicon d) Cds

10) The width of junction barrier varies inversely as the _____ of impurity concentration.

a) square b) square root c) cube d) cube root

11) When ($\alpha_1 + R_2$) approaches _____, the SCR triggers.

a) 1 b) 0.5 c) 10 d) 100

12) A triac is a _____ controlled device.

a) current b) voltage c) power d) both a and b

13) Power consumption of a CMOS is interms of ____

a) Watt b) mW c) MW d) nW

14) Γ -point means

a) $K = \pm\pi$ b) $K = \pm 2\pi$ c) $K = 0$ d) $k = \frac{1}{2\pi}$

2. Attempt the following **(any three)** : **14**

1) Write a note on CMOS. **5**

2) Modern MOSFET's are fabricated on <100> Si – Comment. **5**

3) Write and explain PWT as a relaxation oscillator device. **4**

4) Write a note on PIN diode. **4**

3. a) Using Poissons equations, establish the relations between surface potential (ψ_s), surface charge (Q) and the electric field (E) across a MIS-diode in deep depletion. **10**

   b) Give the principle of charge storage mechanism. **4**

4. a) Discuss the I-V curve of tunnel diode referred to : **10**
      i) tunneling current
      ii) thermal current.

   b) Determine the characteristic impedance of a nearly loss less transmission line (R very small) that has an unit length inductance of 10 nH and an unit length capacitance of 4 pF. **4**

5. a) Discuss the complex I-V characteristic of an SCR. Explain the effect of gate control on it. **10**

   b) Write a note on interface trapped charges. **4**

6. a) Sketch and explain basic 3-phase CCD. Discuss how a charge packet is transferred along the surface of a continuous substrate. **10**

   b) Write a note on photo SCR. **4**

7. a) Write a note on solar cell. **14**

   b) Give a brief account of reverse recovery characteristic of a power diode.

   c) What is flat band shift ?

SLR-MH – 497

Seat No.	

M.Sc. – II (Semester – III) (Old CGPA) Examination, 2016
MATERIALS SCIENCE
Paper – XI : Elements of Materials Science

Day and Date : Saturday, 2-4-2016 Max. Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

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

1. A) Choose correct alternative : **8**

1) Strength of covalent bonds is _____ than that of hydrogen bonds.
   a) Less than b) Greater than
   c) Equal to d) None of the above

2) Type of bonding in NaCl is
   a) Covalent b) Ionic
   c) Hydrogen d) Van der Walls

3) Electrical conductivity of semiconductor is _____ carrier mobilities.
   a) Inversely proportional to b) Directly proportional to
   c) Not related to d) None of the above

4) If remission of light occurs for longer times, the phenomenon is called
   a) Phosphorescence b) Radiation
   c) Diffraction d) Fluorescence

5) Response of Photodiodes is _____ that of photoconductors.
   a) Faster than b) Slower than
   c) Equal to d) None of the above

6) Two-dimensional nanostructures are
   a) Quantum dots b) Quantum wells
   c) Quantum wire d) None of the above

7) Firing is a process used in the production of
   a) Semiconductors b) Metals
   c) Ceramics d) Polymers

8) Polymers are materials with _____ molecular weight.
   a) Very high b) Very low
   c) Constant d) None of the above

B) Fill in the gaps : **6**

1) For N-type semiconductors the position of Fermi-energy level is _____
2) Relation between resistance and length is _____
3) Electrical conductivity of ceramics is very _____
4) Basic unit of polymers is called a _____
5) Electrical conductivity of semiconductors _____ with temperature.
6) _____ are the weak bonds.

2. Attempt **any two** : **14**

1) Discuss classification of ceramics.
2) What do you mean by degree of polymerization ? Which properties of polymers are affected by it ?
3) What are the properties of polymers that are relevant to their typical applications ?

3. a) Discuss with example covalent bonds and molecular bonds. **6**

b) How solids are classified on the basis of band-theory ? **8**

4. a) Discuss with a neat diagram crystal structure of Germanium. **6**

b) What is the effect of temperature on position of Fermi level in extrinsic semiconductors ? **8**

5. a) Derive an expression for thermal equilibrium hole concentration in p-type semiconductors. **8**

b) Explain the concept of excitons. How do they form ? **6**

6. a) Write a short note on photoluminescence. **6**

b) Explain with example different nanostructures. **8**

7. a) Explain the working of photodetector in a circuit biasing it. **8**

b) How do the properties of nanostructures differ from their bulk counterparts ? **6**

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SLR-MH – 498

Seat No.	

M.Sc. (Part – II) (Semester – III) (Old CGPA) Examination, 2016
MATERIALS SCIENCE
Paper – XII : Dielectric and Ferroelectric Materials

Day and Date : Tuesday, 5-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

***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.*

1. Objective questions : **14**

a) Select correct alternative : **6**

i) Materials which can store electrical energy are called
A) Magnetic materials B) Semi conductors
C) Dielectric materials D) Super conductors

ii) Dielectric materials are
A) Insulating materials B) Semiconducting materials
C) Magnetic materials D) Ferroelectric materials

iii) Permanent magnets are made of
A) Soft magnetic materials B) Hard magnetic materials
C) Semi conductors D) Super conductors

iv) Dielectric constant of vacuum is
A) infinity B) 100 C) one D) zero

v) Holes are majority carriers in
A) P-type semiconductors B) N-type semiconductors
C) Insulators D) Superconductors

vi) Which of the following is a derived quantity ?
A) mass B) velocity C) length D) time

b) State **true** or **false** : **8**

i) The SI units of length, mass and time are the meter, gram and second respectively.

ii) Electric current is typically measured in ampere.

iii) The erg is a unit of force in the cgs system.

iv) Inertia is a vector quantity, it has both magnitude and direction.

v) Magnetic susceptibility is the dimensionless quantity.

vi) A piece of magnetic materials has net magnetic moment when no field is applied, it must be therefore be ferromagnetic.

vii) In photoelectric effect, the brighter the light, the more energy of the ejected electrons.

viii) Pyroelectricity is only found is centro-symmetric crystal.

2. Write short notes on :

a) Mechanism of electric polarization. **5**

b) Linear Electro-optic effect in Ceramics. **5**

c) Mechanism in $BaTiO_3$. **4**

3. a) Derive the Clausius – Mosotti equation. **10**

b) What is polarisation ? Explain. **4**

4. a) Derive the Debye Equation. **8**

b) Explain the electrical Charge carriers and their motion. **6**

5. a) Differentiate between Luminescence, Photoluminescence and Fluorescence. Give two applications of each. **10**

b) What is modulation of light ? **4**

6. a) Explain photoemission from electrical contacts from a metal into wide bandwidth semiconductors with the help of energy band. **10**

b) Explain the Photoelectro-Magnetic (PEM) effect. **4**

7. a) Explain Ferroelectric Transition and antiferroelectric Transition. **8**

b) What are ferroelectrics ? Give its applications. **6**

SLR-MH – 499

Seat No.	

M.Sc. (Part – II) (Semester – IV) (New – CGPA) Examination, 2016
MATERIALS SCIENCE
Paper – XIII : Computational Methods and Programming

Day and Date : Wednesday, 30-3-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

Instructions *: 1) Q. No.* ***1*** *and Q. No.* ***2*** *are* ***compulsory****.*
2) Answer ***any three*** *questions from Q. No.* ***3*** *to Q. No.* ***7****.*
3) ***Use*** *of non-programmable calculator is* ***allowed****.*
4) ***All*** *questions are* ***compulsory****.*

1. a) Choose the correct alternative : **6**

i) For solving set of equation AX = B, in which method, coefficient matrix A is transformed to upper triangular matrix

A) Gauss-Seidal method B) Gauss elimination method
C) Gauss Jordan method D) Gauss Jacobi method

ii) In solving a set of simultaneous ordinary differential equations by 4^{th} order Runge Kutta method, if y(0) = 0, h = 0.1, $k_1 = 0.2$, $k_2 = 0.2150$, $k_3 = 0.2171$ and $k_4 = 0.2359$ then value of y(0.1) = ?

A) 0.2066 B) 0.1618
C) 0.2166 D) 0.3616

iii) Using the principle of least square, first normal equation of the curve $y = ce^{dx}$ will be

A) $\Sigma \log y = n\Sigma \log c + d\Sigma \log x$

B) $\Sigma y = n\Sigma c + d \log x$

C) $\Sigma \log y = n\Sigma c + d\Sigma \log x$

D) $\Sigma \log y = n\Sigma \log c + d\Sigma x$

iv) Gauss Seidal method converges only, if the coefficient matrix is

A) Singular matrix B) Non-singular matrix
C) Diagonally dominant D) Upper triangular matrix

P.T.O.

v) Using Bisection method the $(n + 1)^{th}$ approximation formula for the real root of the equation $f(x) = 0$ is given by

A) $\frac{x_n + x_{n-1}}{3}$ B) $\frac{x_{n-1} + x_{n-2}}{2}$

C) $\frac{x_n + x_{n-1}}{2}$ D) $\frac{x_{n-1} + x_{n-3}}{3}$

vi) Milne method is used

A) To solve ordinary D.E.

B) To find out the root of algebraic equation

C) To evaluate integration

D) None of these

b) State **True** or **False** : **8**

i) The Principle of least square is based on Maximizing the ΣE_i^2, where $E_i = (y_i - y)^2$.

ii) The positive real root of the equation $x^3 + 3x - 1 = 0$ lies between 1 and 2 subpart. To predict Adam's Method at least 2 values of y, prior to the desired values are required.

iii) In Newton's Cotes formula if f(x) is interpolated at equally spaced nodes by a polynomial of degree two then it represents three eight rule.

iv) To fit the straight line $y = b + xa$ to N observations, the normal equations are $\Sigma y = a\Sigma x + bN$; $\Sigma xy = a\Sigma x^2 + b\Sigma x$.

v) The value of $I = \int_0^{0.5} x\,dx$ by Simpson's $1/3^{rd}$ rule is 0.125.

vi) Gauss Jordan method for solving the system AX = B fails if matrix A is diagonally dominant.

vii) Gauss Elimination is an iterative method.

viii) The Lagrange's interpolation formula is used for both equally spaced as well as unequally spaced data.

2. Write short notes on :

   a) Write a note on Quadratures and explain how to arrive at Simpson's one third rule. **5**

   b) What are random numbers ? Explain its use. **4**

   c) Write a note on need of numerical solution of the differential equations. **5**

3. a) Write a note on Newton Raphson method. Find a positive root of $x \sin x + \cos x = 0$ by False Position Method. **8**

   b) Using improved Euler method find y at x = 0.1 and y at x = 0.2, given $\frac{dy}{dx} = y - \frac{2x}{y}$ with y(0) = 1. **6**

4. a) Evaluate the integral $I = \int_0^2 \frac{dx}{x^2 + x + 1}$ by Simpson's one third rule by dividing interval in eight parts. **6**

   b) Find the value of y(0.638) for the following data : **8**

x	0.61	0.62	0.63	0.64	0.65	0.66	0.67
y	1.840431	1.858928	1.877610	1.896481	1.915541	1.934792	1.954237

5. a) The curve $y = cd^x$ is fitted to the data :

x:	2	3	4	5	6	8
y:	8.3	15.4	33.1	65.2	126.4	146

   Find the best values of c and d. **8**

   b) Solve the system of equation by Gauss-Jordan method, **6**

   $10x - 7y + 3z + 5w = 6$

   $-6x + 8y - z - 4w = 5$

   $3x + y + 4z + 11w = 2$

   $5x - 9y - 2z + 4w = 7$

6. a) Perform four iterations of false position method to find the positive root of the equation $x\tan x - 1 = 0$ by taking $x_0 = 2.5$ and $x_1 = 3$. **8**

   b) Solve the following system of equation by Gauss Seidal method :

   $28x + 4y - z = 32$

   $2x + 17y + 4z = 35$

   $x + 3y + 10z = 24$. **6**

7. a) Evaluate $\int_0^{0.8} e^{-x^2} dx$, using Romberg's method. **8**

   b) Given $\frac{dy}{dx} = \frac{1}{2}\left(1 + x^2\right)y^2$ and y(0) = 1, y(0.1) = 1.06, y(0.2) = 1.12, y(0.3) = 1.21, find y(0.4) by Milne's Prdictor Corrector Method. **6**

SLR-MH – 500

Seat No.	

M.Sc. – II (Semester – IV) Examination, 2016
MATERIALS SCIENCE
Paper – XIV : Microelectronics (CGPA) (New)

Day and Date : Friday, 1-4-2016 Max. Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Questions **1** and **2** are **compulsory**.*
*2) Attempt **any 3** questions from Q. No. **3** to Q. No. **7**.*
*3) **All** questions carry **equal** marks.*
*4) **Use** of non-programmable calculator is **allowed**.*

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

1) For microelectronic applications, growth of single crystal Si along _____ is favoured.

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) Glassivation is usually done by

a) CVD b) CBD c) ECD d) MBE

4) 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

5) In a constant source diffusion, surface concentration is always

a) decreasing b) increasing
c) constant d) both a) and b)

6) An important advantage of ion implantation is that it is a _____ process.

a) low pressure b) low temperature
c) high temperature d) high pressure

P.T.O.

7) The crystallographic structure of an epitaxial layer and the substrate are
   a) the same
   b) different
   c) close to each other
   d) none of the above

8) Fick's first law of diffusion is expressed as
   a) $j = D\frac{\partial N}{\partial x}$
   b) $j = -\frac{\partial^2 N}{\partial x^2}$
   c) $j = -D\frac{\partial N}{\partial x}$
   d) $j = -\frac{\partial N}{\partial x}$

9) The tetrahedral radius of Si is
   a) 1.18 nm
   b) 1.18 mm
   c) 1.18 A°
   d) 0.118 A°

10) Base diffusion in transistor is usually carried out by _____ source diffusion.
   a) constant
   b) instantaneous
   c) both a) and b)
   d) none of the above

11) Molecular Beam Epitaxy (M B E) is a _____ process.
   a) CVD
   b) ECD
   c) Non-CVD
   d) Sputter

12) Eutectic process assures
   a) low moisture packages
   b) low shear strength
   c) contamination
   d) low thermal stress

13) In electron beam lithography, the stored energy in the resist forms
   a) an actual image
   b) virtual image
   c) diffraction phenomena
   d) scattering only

14) Virtually all MOS technologies use Si - wafers with the crystal surface as _____ orientation.
   a) < 100 >
   b) < 111>
   c) <101>
   d) <110 >

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

   a) An etchback effect **5**

   b) Characteristics of a good photoresist **5**

   c) Substitutional diffusion. **4**

3. a) Give a brief account of vapour phase epitaxy for the growth of single crystal silicon. **10**

   b) What is a negative photoresist ? **4**

4. a) State and explain Fick's 1st law of diffusion. **10**

   b) Explain in brief an interstitial diffusion. **4**

5. a) Discuss a CVD technique for deposition of polysilicon. **10**

   b) What is metallization ? **4**

6. a) Give a brief account of gas-source system for diffusion of boron in silicon. **10**

   b) Write a note on electron beam lithography. **4**

7. a) Explain an NMOS IC-technology referred to **10**

      i) fabrication process sequence and

      ii) special considerations

   b) Write a note on wirebonding. **4**

SLR-MH – 501

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2016
MATERIALS SCIENCE (New) (CGPA)
Paper – XV : Magnetic Materials

Day and Date : Monday, 4-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

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

1. a) Choose correct alternative : **8**

1) Magnetic permeability has units as
   a) Wb/m^2 b) Wb/A.m
   c) A/m d) Tesla/m

2) _____ is an example of para-magnetic material.
   a) Super conductors b) Alkali metals
   c) Transition metals d) Ferrites

3) Typical size of magnetic domains is _____ mm.
   a) 1 – 10 b) 0.1 – 1
   c) 0.05 d) 0.001

4) Example for hard magnet is _____
   a) 45 Permalloy b) CrO_2
   c) Fe-Pd d) Alnico

5) When the north poles of two bar magnets are brought close together, there will be _____
   a) No force b) A downward force
   c) A force of attraction d) A force of repulsion

6) The ability of a material to remain magnetized after removal of the magnetizing force is known as _____
   a) Permeability b) Reluctance
   c) Hysteresis d) Retentivity

P.T.O.

7) A magnetic flux of 2.5×104 Wb through an area of 5×104 square meters results in
   a) 5 Wb
   b) 0.5 Tesla of flux density
   c) 5×10^{-5} Wb of flux
   d) 5000 Tesla of flux density

8) What is the reluctance of a magnetic path having a length of 2×10^{-3} m and cross-sectional area of 2.5×10^{-3} m^2 ?
   a) 6366 A.t/Wb
   b) 6000 A.t/Wb
   c) 8×10^{-3} A.t/Wb
   d) 0.8 A.t/Wb

b) State **true** or **false** : **6**

1) Mixture is a substance whose molecules consist of the same kind of atom.
   a) True b) False

2) Mica is used as the dielectric material in high voltage transformers.
   a) True b) False

3) One farad equals 1 coulomb/volt.
   a) True b) False

4) Hardened steel is used by permanent magnets as the magnetic material.
   a) True b) False

5) Abundance of ferromagnetic material that can be temporarily magnetized is the main advantage of temporary magnets.
   a) True b) False

6) The force between two magnetic poles is directly proportional to their pole strengths.
   a) True b) False

2. Write a short note on : **14**
   1) Magnetic Resonance. **5**
   2) Ferromagnetic Alloys. **5**
   3) Polycrystalline Materials. **4**

3. a) Explain in details the quantum theory of para-magnetism. **8**
   b) Explain the molecular field theory below T_N in antiferromagnetism. **6**

4. a) Discuss the physical origin of crystal anisotropy. **8**
   b) Give a brief account of saturation magnetization in ferromagnetic materials. **6**

5. a) Explain the structure of hexagonal ferrites in ferromagnetic materials. **8**
   b) Explain torque curves method for measurement of anisotropy constants of a crystal. **6**

6. a) Explain the effect of stress on magnetic properties of materials. **8**
   b) Write a note on applications of magnetostriction. **6**

7. a) What are domain walls ? Explain domain wall structure in detail. **8**
   b) Discuss any method for the determination of the susceptibility. **6**

SLR-MH – 502

Seat No.	

M.Sc. – II (Semester – IV) Examination, 2016
MATERIALS SCIENCE (New CGPA)
Paper – XVI : Nanoscience and Nanotechnology

Day and Date : Wednesday, 6-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

***Instructions** : 1) Attempt **five** questions.*
*2) Q. (**1**) and (**2**) are **compulsory**.*
*3) Attempt **any three** from Q. **3** to Q. **7**.*
*4) **Use** of nonprogrammable calculator is **allowed**.*

1. Select the alternatives : **14**

1) A quantum dot is a nanomaterial of dimension
   a) Four b) Three
   c) Zero d) One

2) Bucky balls are made of
   a) C60 molecule b) A metallic glass
   c) A polymeric material d) Superconductor

3) Which one of these statement is false ?
   a) Gold at the nanoscale is red
   b) Copper at the nanoscale is transparent
   c) Silicon at the nanoscale is insulator
   d) Silver at the nanoscale is yellow

4) What is grapheme ?
   a) A new materials made from carbon nanotubes
   b) A one-atom thick sheet of carbon
   c) Thin film made of fullerenes
   d) A software tool to measure and graphically represent nanoparticles

5) The prefix nano comes from
   a) French word meaning billion
   b) Greek word meaning dwarf
   c) Spanish word meaning particle
   d) Latin word meaning invisible

6) Poole-Frenkel effect is present in
   a) Metal
   b) Insulator
   c) Conductor
   d) All of the above

7) Free electron model is a _____
   a) Classical approach
   b) Quantum approach
   c) Both a) and b)
   d) Meissner approach

8) The method of preparation of nanoparticles by formation of colloidal suspension and gelation is
   a) Solvothermal
   b) Sol-gel
   c) Hydrothermal
   d) All of the above

9) The best method to determine the size of Au nanoparticles is
   a) Scanning electron microscopy
   b) Transmission electron microscopy
   c) Atomic force microscopy
   d) Optical microscopy

10) Atomic force microscopy shows images of surface through
   a) The force of the surface on the tip
   b) The electric current that flows from the surface to the tip
   c) Diffraction of electrons around the molecules of the surface
   d) Movement of a laser along the surface

11) Monochromatic (one color) light is sometimes used to increase the resolution of light microscopes. Light of which color below would give you the best resolution ?

a) Blue b) Red

c) Green d) Pink

12) The instrument that produces a bright image of the specimen against a dark background is called a (n) _____ microscope.

a) Phase-contrast b) Electron

c) Bright-field d) Dark-field

13) The electrical conductivity of a nanotube is _____ times that of copper.

a) 10 b) 100

c) 1000 d) 1/100

14) The intensity of the X-rays depends on _____ of materials.

a) Atomic weight

b) Atomic number

c) Volume electron

d) Number of neutron

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

a) Optical absorption in metal and semiconductor. **5**

b) Carbon Buckminster fullerene and Carbon nanotubes. **5**

c) Write a note on Cathodoluminscence and electroluminescence. **4**

3. a) How does atomic force microscopy works ? **10**

b) What are the advantages of an electron microscope over a simple or compound microscope ? **4**

4. a) Classify the growth techniques used for nanomaterial preparation. Explain any two techniques in brief. **8**

   b) Explain the thermally activated conduction and variable range hopping conduction. **6**

5. a) What is the role of Bottom-up and Top-Down approaches in Nano technology ? Give the example of growth techniques of nanomaterials in Bottom-up and Top-Down approaches. **8**

   b) X-rays are electromagnetic radiation of higher energy compared to visible light. If you could see X-rays in the same way you can see light would they appear brighter than light ? Explain. **6**

6. a) Give the detailed working of single and double beam spectrophotometer. **8**

   b) Explain lithography process with limitations over nanolithography. **6**

7. a) Explain the working principle of scanning electron microscope with block diagram. **8**

   b) What is the difference between scanning electron microscope and a transmission electron microscope ? **6**

SLR-MH – 503

Seat No.	

M.Sc. (Part – II) (Semester – IV) (Old) (CGPA) Examination, 2016
MATERIAL SCIENCE
Paper – XIII
Computational Methods and Programming

Day and Date : Wednesday, 30-3-2016 Max. Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

Instructions *: 1) Q. No.* ***1*** *and Q. No.* ***2*** *are* ***compulsory****.*
2) Answer ***any three*** *questions from Q. No.* ***3*** *to Q. No.* ***7****.*
3) Use of Non programmable calculator is ***allowed****.*
4) ***All*** *questions carry* ***equal*** *marks.*

1. a) Choose the correct alternative. **6**

i) Gauss Seidal method converges only, if the coefficient matrix is

A) Singular matrix

B) Diagonally dominant

C) Upper triangular matrix

D) Non singular matrix

ii) In solving a set of simultaneous ordinary differential equations by 4^{th} order Runge Kutta method, if $y(0) = 1$, $h = 0.1$, $k_1 = 0.1$, $k_2 = 0.1150$, $k_3 = 0.1171$ and $k_4 = 0.1359$ then value of $y(0.1) = ?$

A) 0.11668 B) 1.16186 C) 1.11668 D) 0.16186

iii) The normal equation of geometric curve $y = ax^b$ are

A) $\sum \log y = \sum \log\ a + b \sum \log\ x;\ \sum \log\ x \log y = \log a \sum \log x + b \sum (\log x)^2$

B) $\sum \log y = \log a + b \sum \log x;\ \sum \log xy = \log a \sum x + b \sum \log x^2$

C) $y = ax + b;\ \sum xy = na + b \sum x^2$

D) None of these

P.T.O.

iv) When Gauss elimination method is used to solve set of equation AX = B matrix A is transformed to

A) Diagonal matrix

B) Upper triangular matrix

C) Identity matrix

D) Lower triangular matrix

v) The positive real root of the equation $x^3 - x - 11 = 0$ lies between

A) 0 and 1 B) 2 and 3 C) 1 and 2 D) 3 and 4

vi) Adam-Bashforth method is used

A) To find out the root of algebraic equation

B) To solve ordinary D.E.

C) To evaluate integration

D) None of these

b) State **true** or **false**. **8**

i) In Euler's method, given initial value problem $y' = \frac{dy}{dx} = f(x, y)$ with $y(x_0) = y_0$, then the n^{th} approximation is given by $y_{n+1} = y_n + hf(x_{n-1}, y_{n-1})$.

ii) To predict Adam's method at least 2 values of y, prior to the desired values are required.

iii) Gaussian quadrature formula is used to solve differential equations.

iv) To fit the straight line y = ax + b to N observations, the normal equations are $\sum y = a\sum x + bN; \sum xy = a\sum x^2 + b\sum x$.

v) The value of $I = \int_0^{0.5} x^2\,dx$ by Simpson's $1/3^{rd}$ rule is 1.00073.

vi) The positive real root of the equation $x^3 + 3x - 1 = 0$ lies between 0 and 1.

vii) Gauss elimination is an iterative method.

viii) Gauss Jordan method for solving the system AX = B fails if matrix A is not diagonally dominant.

2. Write short notes on :

   a) Write a note on quadratures and explain how to arrive at Simpson's one third rule. **5**

   b) What are random numbers ? Explain its use. **4**

   c) What are algebraic and transcendental equations ? Explain with example. **5**

3. a) Evaluate the integral $I = \int_0^1 e^{-x^2}\, dx$ by taking h = 0.2 using Trapezoidal Rule. **6**

   b) Find the value of f(1) and f(1.8) using for the following data. **8**

x	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
y	0.84147	0.89121	0.93204	0.96356	0.98545	0.99749	0.99957	0.99385	0.97385

4. a) The curve $y = ce^{bx}$ is fitted to the data

x :	1	2	3	4	5	6
y :	1.5	4.6	13.9	40.1	125.1	299.5

   Find the best values of c and b. **8**

   b) Solve the system of equation by Gauss-Jordan method,

   $x + 2y + z = 8$

   $2x + 3y + 4z = 20$

   $4x + 3y + 2z = 16$. **6**

5. a) Perform five iterations of bisection method to find the smallest positive root of the equation $x^3 - 5x + 1 = 0$ and $\cos x - xe^x = 0$. **8**

   b) Solve the following system of equation by Gauss Seidal method,

   $30x - 2y + 3x = 75$

   $2x + 2y + 18z = 30$

   $x + 17y - 2z = 48$. **6**

6. a) Evaluate $\int_0^1 \frac{dx}{1+x^2}$, using Romberg's Integration. And Evaluate $\int_2^4 (2x^2+1)\,dx$ by Gaussian Quadrature method with n = 3. **8**

   b) Given $\frac{dy}{dx} = \frac{1}{2}(1+x^2)y^2$ and $y(0) = 1, y(0.1) = 1.06, y(0.2) = 1.12, y(0.3) = 1.21$, find y (0. 4) by Milne's Predictor Corrector Method. **6**

7. a) Write a note on Newton Raphson Method. Find a positive root of $3x - \sqrt{1+\sin x} = 0$ by False Position Method. **8**

   b) Using improved Euler Method find y at x = 0.1 and y at x = 0.2, given $\frac{dy}{dx} = y - \frac{2x}{y}$ with y(0) = 1. **6**

SLR-MH – 504

Seat No.	

M.Sc. – II (Semester – IV) (Old) (CGPA) Examination, 2016
MATERIALS SCIENCE (Paper – XIV)
Microelectronics

Day and Date : Friday, 1-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

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

1. Choose the corrective alternative : **14**

i) Boron guttering is used to increase the _____
   a) Resistivity b) Conductivity
   c) Mobility d) Carrier concentration

ii) Emitters are normally fabricated by _____ diffusion.
   a) Constant source b) Instantaneous source
   c) Self diffusion d) Both a) and b)

iii) Burried layer is diffused to _____ the conductivity of an epitaxial layer.
   a) Decrease b) Increase
   c) Maintain invariant d) Both a) and b)

iv) Passing of steam through the diffusion furnace is to _____ the oxide layer thickness.
   a) Increase b) Decrease
   c) Maintain the same d) None of above

v) The tetrahedral radius of silicon is _____
a) 11.8 A° b) 8.11 A° c) 0.18 A° d) 1.18 A°

vi) Sheet resistance of an epilayer is usually measured by _____ a technique.
a) Capacitance b) An inductance
c) Four probe d) Two probe

vii) The closest plane of silicon is _____
a) (001) b) (100) c) (111) d) (101)

viii) An upper limit of an impurity concentration in IC fabrication is _____
a) 10^{20} atoms/cm^3 b) 10^{18} atoms/cm^3
c) 10^{19} atoms/cm^3 d) 10^{21} atoms/cm^3

ix) The photographic mask determines the location of _____
a) Impurity concentration b) Windows
c) Photographic plate d) IC-Component

x) In the projected range, distribution of impurity atoms follow almost _____ behaviour.
a) Exponential b) Gaussian c) Linear d) erf.

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

xii) Novolac is a _____ photoresist.
a) Positive b) Negative
c) Both a) and b) d) Neither a) nor b)

xiii) Which isolation is better ?
a) pn-junction b) dielectric c) both a) and b) d) neither a) nor b)

xiv) Very stable resistances are fabricated by a _____
a) Trimming b) Diffusion
c) Laser trimming d) Ion implantation

2. Attempt **any three** : **14**

   a) What is an autodoping ?

   b) Write a note on interstitial diffusion.

   c) Zone process.

   d) To-5 package.

3. a) What is an epitaxy ? Discuss how it is realised in practice. **10**

   b) What is negative photoresist ? **4**

4. a) State and explain Fick's first law of diffusion. **10**

   b) Give a brief account of pn-junction isolation. **4**

5. a) Explain, what do you mean by metallisation ? **6**

   b) Describe in brief a gas-source system for diffusion of boron in silicon. **8**

6. a) What is photolithography ? Discuss with reference to :
      1) photographic mask and
      2) photoresist patterning. **10**

   b) What is doping in melt ? **4**

7. Give a short account of **(any two)** : **14**

   a) Measurement of sheet resistance by 4-probe method.

   b) Fabrication of planar diode.

   c) Ball bonding.

SLR-MH – 505

Seat No.	

M.Sc. – II (Semester – IV) Examination, 2016
(MATERIALS SCIENCE) (Old CGPA)
Paper – XI : Magnetic Materials

Day and Date : Monday, 4-4-2016 Total Marks : 70
Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Q. No. **1** and Q. No. **2** are **compulsory**.*
*2) Answer **any three** questions from Q. No. **3** to Q. No. **7**.*
*3) **All** questions carry **equal** marks.*

1. Objective questions. **14**

a) Select correct alternatives. **8**

1) Basic source of magnetism
   a) Charged particles alone
   b) Movement of charged particles
   c) Magnetic dipoles
   d) Magnetic domains

2) Magnetic permeability has units as
   a) Tesla b) Henry c) Tesla/m d) Henry/m

3) Example for dia-magnetic materials
   a) Super conductors
   b) Alkali metals
   c) Transition metals
   d) Ferrites

4) Typical thickness of Bloch walls _____ (nm).
   a) 0.1 – 1 b) 1 –10 c) 10 – 50 d) 100

5) Above Curie point
   a) A ferromagnetic material becomes paramagnetic
   b) A ferrite becomes an insulator
   c) A insulating material becomes a ferrite
   d) A diamagnetic material, becomes a paramagnetic material

6) In large bulky materials, the uni-axial anisotropy can be induced by
   a) Cold rolling b) Magnetic annealing
   c) Magnetic quenching d) Any of the above

7) The direction of a magnetic field within a magnet is
   a) From south to north b) From north to south
   c) Back to front d) Front to back

8) The ability of a material to remain magnetized after removal of the magnetizing force is known as
   a) Reluctance b) Hysteresis c) Retentivity d) Permeability

b) State **true** or **false**. **6**

1) The unit of magnetic flux density is the Weber.
   a) True b) False

2) The ability of a material to maintain a magnetized state (without the presence of a magnetizing force) is called retentivity.
   a) True b) False

3) The magnetic flux flows from North Pole to South Pole within the magnet.
   a) True b) False

4) Ferromagnetic materials have pre-existing magnetic fields.
   a) True b) False

5) A magnetic field is produced around a current-carrying conductor.
   a) True b) False

6) The induced emf of a conductor cutting flux lines is directly proportional to the rate of cutting.
   a) True b) False

2. Write short notes. **14**

a) Hall Effect **5**

b) Diamagnetic and Para magnetic materials **5**

c) Saturation Magnetization. **4**

3. a) Explain the classical theory of para magnetism. **10**

   b) What is gyromagnetic effect ? **4**

4. a) Explain the Molecular Field Theory of ferromagnetism. **8**

   b) What is band theory ? And explain ferromagnetic alloys. **6**

5. a) Classify the magnetic materials into antiferromagnetic, ferromagnetic, and antiferrimagnetic alloys. Also give examples of each. **10**

   b) Explain the structure of cubic ferrites. **4**

6. a) Explain the physical origin of crystal anisotropy. **8**

   b) What is anisotropy ? And explain it in Cubic and Hexagonal Crystals. **6**

7. a) Explain the effect of stress on magnetostriction and on magnetic properties. Also enlist the applications of magnetostriction. **10**

   b) Explain the domain wall structure. **4**

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SLR-MH – 506

Seat No.	

M.Sc. (Part – II) (Semester – IV) (Old CGPA) Examination, 2016
(MATERIALS SCIENCE)
Paper – XII : Nano – Science and Technology

Day and Date : Wednesday, 6-4-2016 Total Marks : 70

Time : 2.30 p.m. to 5.00 p.m.

Instructions : *1) Q. **1** and Q. **2** are **compulsory**.*

*2) Answer **any three** questions from Q. **3** to Q. **7**.*

*3) **All** questions carry **equal** marks.*

1. Objective questions : **14**

a) Choose correct alternatives : **8**

1) _____ Crystals are very hard with very high melting points.

a) Ionic b) Metallic c) Coulombic d) Covalent

2) The density states for the quantum dot is expressed as

a) $\rho(E)_{0D} = \frac{1}{2\pi^2}\left(\frac{2m^*}{\hbar^2}\right)\sum(E \sim E_{Pot})$

b) $\rho(E)_{0D} = \frac{1}{2\pi^2}\left(\frac{2m^*}{\hbar^2}\right)\sum 2\delta(E \sim E_{Pot})$

c) $\rho(E)_{0D} = \sum 2\delta(E \sim E_{Pot})$

d) $\rho(E)_{0D} = \sum_i 2\delta(E \sim E_i)$

3) The behavior of valence electrons in a crystal structure of a metallic solid is given by _____ model.

a) Drude Model b) Fermi-Dirac Statistics

c) Free electron d) Free exiton

P.T.O.

4) The Law of Mass-Action is

a) $np = n_i^2$ b) $np = n_i$ c) $p = n_i^2$ d) $np = n^2$

5) The Richardson-Schottky equation is given by

a) $J = AT^2 \exp\left[\dfrac{\phi - \left(\dfrac{e^3V}{\varepsilon d}\right)^{\frac{1}{2}}}{kT}\right]$ b) $J = AT^2 \exp\left[\dfrac{\left(\dfrac{e^3V}{\varepsilon d}\right)^{\frac{1}{2}}}{kT}\right]$

c) $J = AT^2 \times \left[\dfrac{\phi - \left(\dfrac{e^3V}{\varepsilon d}\right)^{\frac{1}{2}}}{kT}\right]$ d) $J = AT^2 \exp\left[\dfrac{\phi - \left(\dfrac{e^3V}{\varepsilon d}\right)}{kT}\right]$

6) A Pure _____ material appears red in transmitted light.

a) Amorphous b) Crystalline

c) Both a) and b) d) None of the above

7) Arrange the formation of solgel in order

i) Hydrolysis and Alcoholysis

ii) Agglomeration

iii) Growth of Particles

iv) Condensation and Polymerization

Answer :

a) i, ii, iii, iv

b) i, iv, iii, ii

c) ii, iv, i, iii

d) iii, ii, i, iv

8) AFM is the _____ force between the scanning probe and the conducting surface.

a) Coulombs b) Van der waals

c) Thermal d) Neutron

b) Fill in the gaps : **6**

i) The thermal conductivity of CNT can be compared with _____.

ii) _____ ceramics are a class of materials that expand or contract with respect to voltage and viceverssa.

iii) Method of preparing the nano material based on mechanical crushing process is called _____.

iv) The band gap of ZnO is _____.

v) Boron nitride belongs to III-V and is analogous to _____.

vi) The STM is used for _____ applications.

2. Attempt the following :

i) With necessary theory, explain the phenomenon of thermionic emission. **5**

ii) What is reactive sputtering ? Explain why RF sputtering is preferred for insulating targets. **5**

iii) Show that the Fermi level in the intrinsic semiconductors is given by

$E_F = \frac{E_c + E_v}{2}$ at T = 0K. **4**

3. a) Describe the effect of temperature on Poole-Frankel emission. **8**

b) Mention various types of Physical Vapor Deposition techniques. Briefly explain any one. **6**

4. a) Explain the working principle of Magnetron Sputtering Technique. **8**

b) Discuss why spatial resolution of STM is better than AFM. **6**

5. a) Describe the basic working principle of STM. Explain the charge transfer in terms of LDOS. **8**

b) Describe the classification of Carbon Nano Tubes. What are the unique properties of CNNT. **6**

6. a) With a neat sketch, explain the working principle of TEM. **8**

b) Explain any one of the biological applications of AFM. **6**

7. a) Write a note on Buckminister fullerine. **8**

b) Discuss the characteristic features of BN nanotubes. **6**

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SLR-MH – 668

Seat No.	

M.Sc. (Part – I) (Semester – I) (Old – CGPA) Examination, 2016
PHYSICS (Materials Science)
Paper – IV : Analytical Techniques – I

Day and Date : Tuesday, 5-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

***Instructions** : 1) Attempt **five** questions.*
*2) Q. (**1**) and (**2**) are **compulsory**.*
*3) Attempt **any three** from Q. **3** to Q. **7**.*

1. Select the alternatives : **14**

1) In UV-vis spectrophotometry and atomic absorption spectroscopy, what does absorbance measure ?
   a) The fraction of light of a particular wavelength absorbed by a sample
   b) The fraction of light of a particular wavelength transmitted by a sample
   c) The total amount of light energy absorbed by a sample
   d) The intensity of light that emerges from a sample

2) Which one of the following pieces of information cannot be obtained from an infra-red spectrum ?
   a) The molecular mass
   b) The presence of CO bonds
   c) The identify of a compound through comparison with other spectra
   d) None of the above

3) When an external magnetic field is applied, what happens to the protons in a sample ?
   a) All protons align with the field
   b) All protons align opposite to the field
   c) Some protons align with the field and some align opposite to it
   d) All protons assume a random orientation

4) Which of the following is not a source of visible radiation ?
   a) Deuterium lamp
   b) Tungsten lamp
   c) Xenon arc lamp
   d) None of the above

5) The purpose of the flame in flame atomic-absorption spectroscopy is to
   a) Purify the sample
   b) Desolvate and atomize the analyte atoms in a sample
   c) Excite the analyte atoms
   d) Ionize the analyte atoms

6) A hollow cathode lamp
   a) Is used for fluorescence measurements
   b) Is the most sensitive type of photon detector
   c) Is a source used for infrared spectrophotometry
   d) Can only be used for analysis of the element (s) from which the cathode is made

7) IR spectroscopy is helpful for
   a) Identification of organic compound
   b) Following progress of a reaction
   c) Both a) and b)
   d) None of the above

8) In atomic absorption spectroscopy, which of the following statements is false ?
   a) Flame is used to excite the element to a higher energy state
   b) A hallow-cathode lamp with a cathode made of the element to be analyzed is used to produce a wavelength of light specific for the material
   c) The light is absorbed by the ground state atoms in the flame
   d) There is a net decrease in the intensity of the beam

9) When an external magnetic field is applied, what happens to the protons in a sample ?
   a) All protons align with the field
   b) All protons align opposite to the field
   c) Some protons align with the field and some align opposite to it
   d) All protons assume a random orientation

10) The range of visible spectrum is

a) 200-400 nm b) 400-800 nm

c) 200-600 nm d) 200-800 nm

11) Which of the following is not an advantage of a double beam spectrophotometer ?

a) Double-beam spectrophotometers normally acquire spectra in <1 second

b) Double-beam spectrophotometers compensate for the blank absorbance

c) Double-beam spectrophotometers compensate for changes in the source intensity

d) All of the above are correct

12) In an absorption process, energy is transferred from

a) The light field to absorbing atoms, molecules, or ions

b) Atoms to molecules

c) An excited atom or molecule to a radiation detector

d) Molecules to atoms

13) Two mirrors in the Michelson interferometer (MI) used in FTIR spectrometer should be

a) Perpendicular to each other

b) Parallel to each other

c) Both above arrangement can be used in MI

d) None of the above

14) When radiation interact with a matter which process can occurs ?

a) Absorption b) Scattering

c) Reflection d) All of the above

2. Write a notes on : **14**

1) Chemical shift (δ) and shielding constant (σ) with significance δ>0 and δ<0. **5**

2) Write a note on Mc Lafferty rearrangement. **5**

3) Explain the terms :

i) Anisotropy effect and

ii) Spin-spin coupling. **4**

3. a) Explain the principle and working of mass spectrometer with appropriate diagram. **10**

   b) What are the advantages of IR spectroscopy ? **4**

4. a) Draw the Optical system for a double-beam atomic absorption spectrophotometer and describes the working and principle of AAS. **8**

   b) Explains various modes of vibrations in a molecule. **6**

5. a) Explain the advantages of NMR ? **4**

   b) What is the detection limits and sensitivity in atomic absorption spectroscopy ? **10**

6. a) Explain the working principle and difference between AAS and FES. **8**

   b) Calculate the strength of the magnetic field necessary to produce a difference in the energy of the two spin states of an electron of 10^{-26} J. **6**

7. a) Write in details about the working and principle of dual beam UV-VIS-NIR spectrophotometer with suitable block diagram. **8**

   b) Calculate the difference in the populations of the two nuclear spin states of H nuclei in a magnetic field of 10.0 T at a temperature of 298 K. **6**

SLR-MH – 669

Seat No.	

M.Sc. (Part – I) (Semester – II) (Old – CGPA) Examination, 2016
PHYSICS
Materials Science
Paper – VIII : Analytical Techniques – II

Day and Date : Wednesday, 6-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

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

1. A) Choose correct alternatives : **8**

1) The intensity of beam diffracted by all the atoms of the unit cell is proportional to

a) F^2 b) F c) 1/F d) $F^{-1/2}$

2) Which of these properties must change for a mode to be Raman active ?

a) Volume b) Dipole moment
c) Polarisability d) All of the above

3) The main technique used to study the surface morphology of a material is

a) FTIR spectroscopy
b) UV-Vis absorption spectroscopy
c) Scanning electron microscopy
d) X-ray diffraction

4) In case of tetragonal crystal system

a) a = b = c b) a = b ≠ c c) a ≠ b ≠ c d) a ≠ b = c

5) Which of the following analytical techniques, based on the Bragg equation, may be used to reveal the crystalline components of paints on the basis of their crystal structures ?

a) Raman spectroscopy
b) X-ray diffraction
c) Infrared spectroscopy
d) None of the above

P.T.O.

6) The rotational structure in the Raman spectrum of carbon dioxide, CO_2 is offset from the wave number of the incident radiation by 2.3622 cm^{-1}, 5.5118 cm^{-1}, 8.6614 cm^{-1}, _____. Determine the rotational constant of carbon dioxide.

a) 0.3937 cm^{-1} b) 0.3857 cm^{-1} c) 0.2931 cm^{-1} d) 0.1231 cm^{-1}

7) A compound shows IR absorption in the range 2100-2260 cm^{-1} is due to the presence of

a) C = N b) C = C c) C = H d) C = O

8) Which of the following combinations would give the best microscopic resolution ?

a) small numerical aperture lens, long-wavelength radiation

b) small numerical aperture lens, short-wavelength radiation

c) large numerical aperture lens, long-wavelength radiation

d) large numerical aperture lens, short-wavelength radiation

B) Fill in gaps : **6**

i) _____ type of scattering is the strongest in Raman scattering.

ii) The coordination number of bcc structure is _____

iii) _____ mode is the combination of contact and non-contact mode in AFM.

iv) _____ refers to the measurement of kinetic energy spectra of photoelectrons emitted by molecules which have absorbed ultraviolet photons, in order to determine molecular orbital energies in the valence region.

v) _____ material is used for the sample preparation in FTIR.

vi) The wavelength of continuous X-rays depends upon _____

2. Write a notes on :

1) Chemical shift, quantification and depth-profiling (σ) in X-ray photoelectron spectroscopy. **5**

2) Write a note on Attenuated Total Reflection (ATR). **5**

3) Explain the terms : **4**

i) Atomic structure factor

ii) Crystal structure.

3. a) Explain the principle and working of Ultraviolet photo spectroscopy with appropriate block diagram. **8**

   b) Why Fourier Transform Infra Red spectroscopy useful than Dispersive IR spectroscopy (Advantages of FTIR over Dispersive IR) ? With the help of typical FTIR spectrometer layout explain how the constructive and destructive interference pattern generated. **6**

4. a) Describes the working and principle of X-ray diffractometer with appropriate ray diagram. How the particle size can be determined using XRD ? **8**

   b) Write a short notes on EDS and WDS. Why the electrons are used in scanning electron microscopy ? **6**

5. a) Explain the basic principle and instrumentation of XPS. What are the information's one can get from XPS analysis ? **8**

   b) What advantages does Raman spectroscopy have for process monitoring ? **6**

6. a) Explain the working and principle of scanning electron microscopy with block diagram. **8**

   b) Explain the basic concept of determination of lattice parameters in crystal systems. **6**

7. a) Explains contact and taping mode in AFM, what the merits of tapping mode over contact mode. Diagrammatically show how the Van der Wall force depends on the tip distance in atomic force microscope. **8**

   b) Back scattered and secondary electrons in SEM, with the help of scattering. **6**

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