SLR-VH – 1

Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2014
PHYSICS (Materials Science)
Mathematical Techniques (Paper – I)

Day and Date : Monday, 21-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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. A) Select the correct alternative : **8**

1) If the eigen values of a 3×3 matrix A are 2, 5, 6 then, the eigen values of A^2 are _____

a) 2, 5, 6 b) 4, 5, 6 c) 2, 25, 6 d) 4, 25, 36

2) $L^{-1}\left\{\frac{1}{(s-3)^2+16}\right\} =$ _____

a) $\frac{e^{3t}}{4}\sin 4t$ b) $\frac{e^{-3t}}{4}\sin 4t$ c) $e^{3t}\cos 4t$ d) $e^{-3t}\cos 4t$

3) The function f(z) = (x + ay) + i (bx + cy) is analytic if , _____

a) a = 1, b = 2, c = 3 b) a = – b, c = 1
c) a = b = c = 1 d) None of these

4) The conditions for expansion of a function in a Fourier series are known as _____

a) Harmonic b) Riemann conditions
c) Periodic d) Dirichlets conditions

P.T.O.

5) If f(z) is analytic and its partial derivatives are continuous throughout some simply connected region, then for every closed path C within this region $\oint_C f(z)\,dz =$ _____

a) $2\pi i$ b) 1 c) – 1 d) 0

6) The differential equation M(x, y) dx + N(x, y) dy = 0 is exact if _____

a) $\frac{\partial M}{\partial y} \neq \frac{\partial N}{\partial x}$ b) $\frac{\partial M}{\partial x} \neq \frac{\partial N}{\partial y}$ c) $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$ d) $\frac{\partial M}{\partial x} = \frac{\partial N}{\partial y}$

7) L { cos3t} = _____

a) $\frac{3}{S^2+9}$ b) $\frac{S}{S^2+9}$ c) $\frac{3}{S^2-9}$ d) $\frac{S}{S^2-9}$

8) Gaussian distribution function is given by

a) e^{ix^2} b) $Ne^{-\alpha x^2}$ c) $\cos \alpha x$ d) $\sin \alpha x$

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

1) If zero is one of the eigen value of matrix A, then A is singular.

2) $\frac{1}{(S+1)^2}$ is the Laplace transform of te^{-t}.

3) A function ϕ (x, y) having continuous partial derivatives of the first and second order is called harmonic function if $\nabla^2\phi \neq 0$.

4) If the complex Fourier transform of f(x) is F(s), then the complex Fourier transform of $f(x/2)$ is $\frac{1}{2}$ F(2s.)

5) The set of all solutions of an n^{th} order linear homogeneous differential equation forms an n-dimensional vector space.

6) A vector space is said to be n-dimensional if it contains precisely n linearly independent vectors.

2. Write short notes on :

   a) Properties of matrices **4**

   b) Cauchy integral formula **5**

   c) Types of homogeneous and non-homogeneous differential equations. **5**

3. a) Find Fourier series to represent $f(x) = |\sin x|$ for $-\pi \leq x \leq \pi$. **8**

   b) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix}$. **6**

4. a) Using Laplace transform solve **8**

   $(D^2 + D - 2)\, x = 2\,(1 + t - t^2)$, given that $x = 0$, $Dx = 3$, for $t = 0$.

   b) Show that $u = e^x \cos y$ is harmonic and find the corresponding conjugate function. **6**

5. a) The vertical motion of a particle of mass m on a spring with spring constant K is described by the following differential equation $my'' = -ky + mg$ with $y(0) = y_0$ and $y'(0) = 0$. Solve this equation for the position of the particle as a function of time. **8**

   b) Using Parsevals identity, prove that **6**

$$\int_0^{\infty} \frac{dt}{(p^2+t^2)\,(q^2+t^2)} = \frac{\pi}{2pq\,(p+q)}$$

6. a) Solve $x\,(x^2 + 2y^2)\,dx + y\,(2x^2 + y^2)\,dy = 0$. **6**

   b) Find the Fourier transform, F(k) of the Gaussian distribution function, $f(x) = Ne^{-\alpha x^2}$, where N and α are constants. **8**

7. a) Classify the singularities and calculate the residue for **8**

   $f(z) = \frac{1}{(z^2+a^2)^2}$ (where $a > 0$).

   b) Find the inverse Laplace transform of $\frac{2s^2 - 6s + 5}{s^3 - 6s^2 + 11s - 6}$ **6**

SLR-VH – 10

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2014
MATERIALS SCIENCE (Physics)
Instrumentation (Paper – X)

Day and Date : Wednesday, 23-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 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) Choose correct alternatives : **8**

1) The type R thermocouple is formed using
   a) Pt/Pt – Rh b) Iron-Constantan
   c) Copper-Constantan d) Chromel-Alumel

2) Slew rate of IC 741 Op amp _____ microvolt/sec.
   a) 0.6 b) 0.3 c) 0.4 d) 0.5

3) _____ governs phenomena of thermocouple.
   a) Seeback coefficient
   b) Principle of induced emf (Where T is stress)
   c) D = dt
   d) Coulomb force

4) Isolation amplifier is used to isolate _____
   a) Control circuit and load circuit
   b) Load and load circuit
   c) Error voltage and control circuit
   d) Voltage and circuit

P.T.O.

5) _____ is unit of Torque.

a) Newton b) Newton-m^{-2}

c) Newton meter d) Erg

6) Hall probe is used for detection of _____

a) Electric field b) Magnetic field

c) AC current d) DC current

7) Platinum RTD can be used for measuring a temperature unto _____ °C.

a) 250 b) 500 c) 1000 d) 1500

8) Gain of instrumentation amplifier is defined as _____

a) 1 + 2R / RG b) 1 + R1 / R2

c) (1 + 2R1 / RG) (Rf / R1) d) None above

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

1) A photoconductive cell is a _____ transducer.

2) Tacho generator works as _____

3) The operating temperature range of Fe-CN thermocouple is _____

4) RS 232 is a serial communication interface bus.

5) Input is coupled through R = 1 network to DC Amplifier.

6) PH meter is basically a mV – meter.

2. Attempt following : **14**

1) Write a note on S-H circuit. **5**

2) Write a short note on IEEE 488 instrumentation bus. **5**

3) Explain precision half wave rectifier. **4**

3. a) Explain construction and working of circuit and interface for measurement of current DCM. **8**

   b) Calculate Q for A parallel R-C circuit with R = 10 MΩ , C = 100 pf and ω = 1 kHz. **6**

4. a) How differentiator is used to convert angular speed to acceleration consider example of dc tacho generator for measurement of speed / RPM ? **8**

   b) Draw and explain working of the F to V converter. **6**

5. a) Explain construction and working bridge circuit and interface for measurement C using lock in analyzer. **8**

   b) Explain basic principle and interface of Piezoelectric crystal. **6**

6. a) Explain basic principle and interface of PH meter. **8**

   b) What is a DC amplifier and discuss its frequency response ? **6**

7. a) Describe piezoelectric transducer as a voltage to strain converter. **8**

   b) Explain construction and working bridge circuit and interface for measurement of R. **6**

SLR-VH – 11

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2014
MATERIAL SCIENCE (Physics) (Paper – XI)
Elements of Materials Science

Day and Date : Friday, 25-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

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

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

1) The energy gap of Germanium at room temperature is _____ eV.
a) 1.1 b) 0.72 c) 2.1 d) 3.5

2) At 0 K the material behaves like _____
a) insulator b) semiconductor
c) conductor d) none of these

3) Negative refractive index of metals gives rise to _____
a) refraction b) absorption c) scattering d) reflection

4) The simplest and most extensively studied colour center is the _____
a) V-center b) F-center c) P-center d) Q-center

5) When bond length is decreased the bond energy
a) decreases b) increases
c) remains constant d) none of above

6) The conductivity of metal is σ = _____
a) neμ b) ne c) nμ d) none of these

7) Which one of the following is a not a ceramic material ?
a) silicon carbide b) zinc
c) iron d) wood

8) The doped semiconductor is called as _____ semiconductor.
a) extrinsic b) intrinsic c) compound d) none of these

P.T.O.

B) Fill in the blanks : **2**

1) A semiconductor doped with donor impurities is known as _____ semiconductor.

2) The excitation due to application of either ac or dc current as in pn junction is _____

C) State **true** or **false** : **4**

1) The band gap of PbS is 0.4 eV.

2) The materials which are used to produce luminescence are known as Phosphors.

3) At absolute zero temperature an intrinsic semiconductor has no holes or free electrons.

4) The primary bond is formed by intermolecular forces.

2. Answer in short : **14**

a) Explain principle of Photodiode.

b) What are different types of polymerization ?

c) What is luminescence explain how photoluminescence takes place in characteristics luminescent ?

3. a) What are the different methods used for the synthesis of nanophase materials ? **10**

b) Explain classification of solid based on energy band diagram. **4**

4. a) Deduce an expression for intrinsic concentration using mass action law. **8**

b) Explain effect of temperature on carrier concentration and fermi level in an extrinsic semiconductor. **6**

5. a) Explain the polymerization mechanism with suitable examples. **8**

b) Write a note on properties of nanoparticles. **6**

6. a) Give an account of the various properties of engineering materials. **8**

b) Explain an ionic bond with examples. **6**

7. a) Explain the characteristics features of different photoconductive material. **8**

b) Explain the crystal structure of silicon and Germanium. **6**

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SLR-VH – 12

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2014
MATERIAL SCIENCE (Physics) (Paper – XII)
Dielectrics and Ferroelectric Materials

Day and Date : Monday, 28-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 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) Choose correct alternatives :

1) The relation between induced charges (q') in dielectric medium (K) and free charges (q) is _____

a) q' = q (1 + 1/K) b) q' = q (1 – 1/K)

c) q' = q (1 + K/q) d) q' = q (1 + q.K)

2) The relation between $\vec{D}$, $\vec{E}$ and $\vec{P}$ is _____

a) $\vec{D} = \varepsilon_o \vec{E} + \vec{P}$ b) $\vec{D} = \varepsilon_o \vec{E} - \vec{P}$

c) $\vec{P} = \varepsilon_o \vec{E} + \vec{D}$ d) $\vec{P} = \varepsilon_o \vec{E} - \vec{D}$

3) Dielectric materials are primarily used for _____

a) Insulation b) To store charges

c) Reducing dielectric losses d) None of these

4) Which materials exhibit hysteresis curve in the polarization when an electric field is applied ?

a) dielectric b) antiferroelectric

c) ferroelectric d) all of these

P.T.O.

5) The direction of induced emf in an electromagnetic induction is given by _____

a) Biot-Savart law b) Ampere's law

c) Faraday's law d) Lenz law

6) The band gap of silicon materials is _____

a) 0.4 eV b) 0.7 eV c) 1.1 eV d) 1.4 eV

7) Calculate the threshold frequency of photosensitive material whose work function is 4 eV.

a) 9.66×10^{14} Hz b) 7.89×10^{13} Hz

c) 4.99×10^{12} Hz d) 5×10^{15} Hz

8) The losses in dielectric subjected to alternating electric field are determined by

a) Real part of complex dielectric constant

b) Imaginary part of complex dielectric constant

c) Both real and imaginary part of complex dielectric constant

d) None of these

B) **True** or **false** :

1) Piezoelectric effect is production of electricity by pressure.

2) WO_3 is ferroelectric materials.

3) If the time delay between absorption and re-emission is less than 10^{-8} s, the material is called phosphorescent.

4) Polymers have molecules that are very long and chain like, usually extends several thousand angstroms.

5) The carrier life time is equal to the time in which the excess carriers fall to 73% of its initial value.

6) The defects are essential for ionic conduction in crystalline solids.

2. Attempt the following :

a) Prove that $\vec{\nabla} \cdot \vec{B} = 0$ and state its physical significance. **6**

b) What are the applications of ferroelectric materials in different field ? **4**

c) Write note on MIS solar cells, including basic structure and energy band diagram. **4**

3. a) Explain principle and working of Photovoltaic cells and also the important points that are taken into account to design solar cells. **8**

   b) Write note on electro-optic ceramics. **6**

4. a) What is meant by polarization mechanism in dielectrics ? Discuss the different polarization mechanisms in dielectrics and explain in brief their temperature dependence. **10**

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

5. a) Obtain Clausius-Mosotti equation and explain how it can be used to determine the dipole moment of a polar molecule from the dielectric constant measurement. **10**

   b) Explain NTC and PTC materials with suitable examples and their uses. **4**

6. a) Explain the classification of ferroelectric materials based on their chemical composition and their structure. **10**

   b) Write note on PIN structures for amorphous Si-based photovoltaic devices. **4**

7. a) Explain the phenomenological approach to piezoelectric effect. Discuss various piezoelectric parameters and way of their measurements. **8**

   b) Derive Kramers-Kronig relations to derive relation between dielectric constant and dielectric loss factor and interpret the results. **6**

SLR-VH – 13

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2014
PHYSICS (Materials Science) (Paper – XIII)
Computational Methods and Programming

Day and Date : Tuesday, 22-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions : *1) Attempt in **all five** questions.*
*2) Q. **1** and Q. **2** are **compulsory**.*
*3) Attempt **any three** questions from Q. **3** to Q. **7**.*

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

i) $y_1 = y_0 + \frac{h}{24}(9f_1 - 19f_0 - f_{-1} + f_{-2})$ is _____

a) Milne's predictor formula
b) Adam's predictor formula
c) Milne's corrector formula
d) Adam's corrector formula

ii) In solving simultaneous equation by Gauss elimination method, the coefficient matrix is reduced to _____

a) Lower triangular form b) Upper triangular form
c) Diagonal form d) None of the above

iii) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x, y)$ is known as _____

a) Laplace equation b) Poisson's equation
c) Heat equation d) None of the above

iv) The solution of any ordinary differential equation in 'n' unknowns can be written as _____

a) $y(t) = y(t_0) - \int_{t_0}^{t} f[y(t'), t']dt'$ b) $y(t) = y(t_0) + \int_{t_0}^{t} f[y(t'), t']dt'$

c) $y(t_0) = y(t) - \int_{t_0}^{t} f[y(t'), t']dt'$ d) $y(t_0) = y(t) + \int_{t_0}^{t} f[y(t'), t']dt'$

P.T.O.

v) Square matrix is called orthogonal if _____

a) $A = A^2$ b) $A^1 = A^{-1}$

c) $AA^{-1} = I$ d) None of the above

vi) $\frac{dy}{dt} \pm i\omega y = 0$ is the oscillation equation with solution _____

a) $y = y_0 \exp(-i\omega t)$ b) $y = y_0 \exp(+i\omega t)$

c) $y = y_0 \exp(\mp i\omega t)$ d) $y = y_0 \exp(\mp \omega t)$

vii) Amplification factor for hyperbolic equation is _____

a) $g = 1 + i\alpha$ with $\alpha = \frac{C\delta t}{\delta x} \sin(K\delta x)$

b) $g = 1 - i\alpha$ with $\alpha = \frac{C\delta t}{\delta x} \sin(K\delta x)$

c) $g = 1 + i\alpha$ with $\alpha = \frac{C\delta t}{2\delta x} \sin(K\delta x)$

d) $g = 1 + i\alpha$ with $\alpha = \frac{C\delta t}{2\delta x} \cos(K\delta x)$

viii) If K = 60, the maximum value generated by the random function random (K) will be _____

a) 60 b) 61

c) 59 d) 600

1. B) Fill in the blanks/State **True** or **False** : **6**

i) Positive definite matrices used in _____ calculations.

ii) Jacobi iteration method can be used to solve a system of _____ equations.

iii) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ is known as _____ equation.

iv) A simple algorithm method is always unstable for the advective equation.

v) Random numbers are generated in descending order.

vi) Using Euler's method $\frac{dy}{dx} = \frac{(y - 2x)}{y}$, with y(0) = 1 gives y(0.1) = 1.1818.

2. Attempt following : **14**

   i) For the equation $\frac{dy}{dt} + \alpha y = 0$ develop an algorithm based on Runga-Kutta method.

   ii) Determine X_1 to X_6 of a pseudo random numbers series. Given – $X_1 = 2$, $a = 13$, $b = 7$.

   iii) Solve the nonlinear equations $x = 2(y + 1)$, $y^2 = 3xy - 7$, correct to the three decimals.

3. a) What do you mean by iterative method for solving the matrix equation ? $AX = B$ Explain the Jacobi Method. **8**

   b) Solve the following equation using Jacobi Method. **6**

$$\begin{pmatrix} 20 & 1 & -2 \\ 3 & 20 & -1 \\ 2 & -3 & 20 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 17 \\ -18 \\ 25 \end{pmatrix}$$

4. a) How Poisson's Equation could be represented in the form of Tridiagonal matrix ? **10**

   b) In case of pseudo random numbers if $b = 5$, after how many numbers the sequence of random number repeats. Why ? **4**

5. a) Express general form of first order ODE and solution y(t). What do you mean by boundary conditions ? Thus explain Leep-Frog Method to numerically solve the ODE. **10**

   b) What are differential equations ? Discuss with example different types of differential equations and define order of a differential equation. **4**

6. a) Show that the Runge-Kutta method is stable for decay and oscillation equation but unstable for growth equation. Write down the algorithm for Runge-Kutta method. **10**

   b) Find the inverse of the matrix $\begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}$. **4**

7. a) What is diffusion equation ? How this equation satisfies the condition of being parabolic ? Express an algorithm to solve the Diffusion equation. **10**

   b) Determine first four values for the equation ; $\frac{dy}{dt} + 10y = 0$; Given $y_0 = 1$. **4**

SLR-VH – 14

Seat No.	

M.Sc. – II (Semester – IV) Examination, 2014
PHYSICS (Materials Science)
Paper – XIV : Microelectronics

Day and Date : Thursday, 24-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

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

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

1) The length of a typical zone in the zone process is _____

a) 1 cm b) 1.5 cm
c) 2 cm d) 3 cm

2) For an instantaneous source diffusion, the doping profile is _____

a) Logarithmic b) Linear
c) Gaussian d) erf.C.

3) Novolac is a _____ photo resists.

a) Negative b) Positive
c) Both a) and b) d) None of the above

4) An aspect ratio is _____

a) L/W b) W/L
c) R/L d) L/R

5) The purple plague is _____

a) $AuAl_2$ b) Au.Al
c) $AuAl_3$ d) Al_2O_3

P.T.O.

6) An important advantage of an ion implantation is that the process is a _____ temperature process.
   a) Low b) High
   c) Intermediate d) None

7) Which isolation is better for fabrication of IC's ?
   a) pn-junction b) Dielectric
   c) Both a) and b) d) None

8) Very stable high resistances are fabricated by a _____
   a) Diffusion b) Trimming
   c) Laser trimming d) Etching

9) Emitters are normally fabricated by _____ diffusion.
   a) Constant source b) Instantaneous source
   c) Dielectric d) None

10) In the projected range, the distribution of impurity atoms follows almost _____ behaviour.
   a) Gaussian b) erf.C.
   c) Linear d) Exponential

11) A dielectric isolation _____ the parasitic capacitance.
   a) Increases b) Decreases
   c) Does not affect d) None of the above

12) Silicon is _____ packed structure.
   a) Loosely b) Closely
   c) Random d) Disordered

13) Zone levelling is a technique of _____ Si-bar.
   a) Refining b) Diffusion
   c) Exchange d) Doping

14) The base width of a normal npn-transistor is of the order of _____ μm.
   a) 6 to 8 μm b) 0.06 to 0.08 μm
   c) 0.6 to 0.8 μm d) 1 to 2 μm

2. Attempt the following : **14**

   1) Substitutional diffusion. **5**

   2) Ficks 2nd law of diffusion. **5**

   3) Stich bonding. **4**

3. a) Define the term epitaxy. How vapour phase epitaxy is used for the fabrication of an n-type epilayer ? **10**

   b) What is an etch-back effect ? **4**

4. a) Discuss in brief an ion implantation process for implantation of ions in the epilayer. **10**

   b) What is projected range ? **4**

5. a) What are pn-junction and dielectric isolations ? **10**

   b) Write a note on oxide formation. **4**

6. a) Explain why Al is preferred in metallisation ? **5**

   b) What is a negative photo resist ? **5**

   c) T0-5 package. **4**

7. a) How are the monolithic planar diodes fabricated ? Give a suitable diode configuration for high voltage/speed application. **10**

   b) Write a note on planar transistors. **4**

SLR-VH – 15

Seat No.	

M.Sc. (Part – II) (Sem. – IV) Examination, 2014
MATERIALS SCIENCE (Physics, Paper – XV)
Magnetic Materials

Day and Date : Saturday, 26-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 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.*

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

1) An instrument to integrate the voltage from a search coil is called as _____

a) gaussmeter b) fluxmeter
c) teslameter d) potentiometer

2) Hall emf is given as e_H = _____

a) $R_H \cdot iH / t$ b) $R_H \cdot t / iH$
c) $iH / R_H \cdot t$ d) $t / R_H \cdot iH$

3) If the body is diamagnetic its susceptibility is always _____

a) negative b) positive
c) zero d) infinite

4) The magnetic moment in the first Bohr orbit due to spin and due to orbital motion is _____

a) zero b) exactly opposite
c) exactly equal d) none of these

5) The 'χ' value in the ferromagnetic is _____

a) large and negative b) large and positive
c) small and negative d) zero and positive

6) Antiferromagnetic substances have a _____ susceptibility.

a) large and positive b) zero
c) small and positive d) infinite

P.T.O.

7) When substance is exposed to magnetic field its dimensions changes, this effect is called as

a) Hall effect b) Magnetostriction

c) Anisotropy d) None of above

8) The first theoretical examination of the structure of a domain wall was made by _____

a) Hall b) F. Block

c) Bohr d) W. Shockley

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

1) Susceptibility (χ) is equal to B/H
2) VSM is also referred as AFGM
3) Band theory is sometime called as classical theory
4) The alignment of domains in the ferromagnetic material is parallel
5) The domain orientation in the antiferromagnetic is equal and antiparallel
6) The direction of easy magnetization in all the cubic ferrite is <110>.

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

1) Write a short note on flux meter. **5**
2) Write note on neutron diffraction. **5**
3) Explain in brief magnetic moments of electron. **4**

3. a) Explain saturation magnetization for ferrimagnetism. **8**

b) Write a note on polycrystalline materials. **6**

4. a) Explain torque curves method for measurement of anisotropy constants of a crystal. **8**

b) Write a note on ΔE effect. **6**

5. a) Explain in detail classical theory of paramagnetism. **8**

b) Explain exchange forces in ferromagnetism. **6**

6. a) Explain origin of magnetostriction mechanism. **8**

b) What is form effect ? **6**

7. a) Explain the effect of stress on magnetic properties of materials. **8**

b) Write a short note on $\gamma - Fe_2O_3$. **6**

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SLR-VH – 16

Seat No.	

M.Sc. (Part – II) (Sem. – IV) Examination, 2014
MATERIALS SCIENCE (Physics)
Paper – XVI : Nano-Science and Technology

Day and Date : Tuesday, 29-4-2014 Total Marks : 70
Time : 3 .00 p.m. to 6.00 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) Choose correct alternatives : **8**

1) The density of states for the free electron model in three dimensions is given by,

a) $D(\varepsilon) = \frac{V}{2\pi^2}\left(\frac{8\pi^2 m}{h^2}\right)^{3/2} \varepsilon^{1/2}$

b) $D(\varepsilon) = \frac{2V}{\pi^2}\left(\frac{8\pi^2 m}{h^2}\right)^{3/2} \varepsilon^{1/2}$

c) $D(\varepsilon) = \frac{V}{2\pi^2}\left(\frac{8\pi^2 m}{h^2}\right)^{1/2} \varepsilon^{1/2}$

d) $D(\varepsilon) = \frac{V}{2\pi^2}\left(\frac{8\pi^2 m}{h^2}\right)^{3/2} \varepsilon^{3/2}$

2) According to Mott formalism, the conductivity at low electric region is _____

a) $\sigma = \sigma_0 \exp\left(\frac{-T_0}{T}\right)1/4$ b) $\sigma = \sigma_0 \exp\left(\frac{-T_0}{T}\right)$

c) $\sigma = \sigma_0 \exp\left(\frac{T_0}{T}\right)1/4$ d) $\sigma = \exp\left(\frac{-T_0}{T}\right)1/4$

3) _____ model describes low temperature electron transport.

a) Drude b) Schottky

c) Poole-Frenkel d) VRH

4) Principle of AFM based on change in force with

a) Temperature b) Pressure

c) Distance d) Size

5) In band structure of solids Heitler-London assumption is _____

a) Electrons are in nonlocalized states

b) Electrons are in mobilized states

c) Electrons are in localized states

d) Electrons are in immobilized states

6) The energy gap of ZnO is _____

a) 1.2 eV b) 2.2 eV

c) 3.2 eV d) 4.2 eV

7) The Arrhenius equation for electron transport is _____

a) $\sigma = \sigma_0 \exp\left(\frac{Ea}{T}\right)$ b) $\sigma = \sigma_0 \exp\left(-\frac{Ea}{T}\right)$

c) $\sigma = -\sigma_0 \exp\left(\frac{Ea}{T}\right)$ d) $\sigma = \exp\left(\frac{Ea}{T}\right)$

8) The contrast transfer function frequently referred to in _____ imaging.

a) TEM b) HRTEM

c) SEM d) FESEM

b) Fill in gaps : **6**

i) _____ is the highest resolution of HRTEM.

ii) The positive part of an image in lithography is generated by _____ substance.

iii) Boron nitride is an III-V analog to _____

iv) AFM is a chemo-mechanical surface patterning technique.

v) STM is the tunneling current between a metallic tip and a conducting substrate.

vi) MBE technique is used to epitaxial growth of materials.

2. Attempt following : **14**

a) Write a note on Schottky effect. **5**

b) Buckminsterfullerene – Explain. **5**

c) Explain the charge transfer in terms of LDOS. **4**

3. a) Describe chemical vapor deposition process. **8**

b) Obtain an expression of electrical conductivity and carrier concentration of intrinsic semiconductor. **6**

4. a) Describe Vapor-liquid-solid method of growth of nanostructures. **8**

b) Describe various process steps involved PLD process. **6**

5. a) Describe working principle and operation of AFM. **8**

b) Give basic difference between a PVD and CVD process. **6**

6. a) What is carbon nanotube ? Explain SWCNT and MWCNT. **8**

b) Write a note on Nanobiometric. **6**

7. a) Explain working principle and operation of STM. **8**

b) Give applications of STM. **6**

_____

SLR-VH – 17N

Seat No.	

M.Sc. – II (Semester – IV) Examination, 2014
PHYSICS (Materials Science)
Paper – XIII : Computational Methods and Programming

Day and Date : Tuesday, 22-4-2014 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

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

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

i) Adam-Bashforth method is used to _____
   a) find out root of the algebraic equation
   b) solve ordinary differential equation
   c) evaluate integration
   d) none of the above

ii) The positive 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

iii) To initialize the random number generator, which library function is used ?
   a) srandu (u) b) fabs (x) c) *f* mod (x, y) d) ceil (x)

iv) The normal equations of regressions for $y = a_0 + a_1 x$ are _____
   a) $na_0 + (\Sigma x_i)a_1 = \Sigma y_i$ and $(\Sigma x_i)a_0 + (\Sigma x_i^2)a_1 = \Sigma x_i y_i$
   b) $na_1 + (\Sigma x_i)a_0 = \Sigma y_i$ and $(\Sigma x_i)a_0 + (\Sigma x_i^2)a_1 = \Sigma x_i y_i$
   c) $na_0 + (\Sigma x_i)a_1 = \Sigma y_i$ and $(\Sigma x_i)a_1 + (\Sigma x_i^2)a_0 = \Sigma x_i y_i$
   d) none of these

v) The order of convergence for Newton-Raphson method is
   a) 1 b) 2 c) 1.66 d) 2.66

vi) The Regula-Falsi method is surely convergent while Newton's method is _____ convergent.
   a) unconditionally b) never
   c) surely d) conditionally

vii) Romberg's method is based on successive application of _____ rule.

a) Trapezoidal b) Simpson's 1/3

c) Simpson's 3/8 d) Weddles

viii) In the Euler's method n^{th} approximation formula for solving $y' = f(x, y)$ is given by a _____

a) $y_{n+1} = y_n + h\, f(x_{n-1}, y_{n-1})$ b) $y_{n+1} = y_n + h\, f(x_n, y_n)$

c) $y_{n+1} = y_n$ d) $y_{n+1} = y_{n-1} + f(x_n, y_n)$

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

i) The Euler's method gives a poor approximation, when dy/dx changes rapidly over the given interval and therefore the Predictor-Corrector method is used.

ii) Newton's forward difference formula is used to find out value of y at x which is present in the lower part of the table.

iii) The elimination including scaled pivoting, is commonly called Gauss elimination.

iv) The sum of the squares of the errors must be minimum. This is the _____ _____ principle.

v) Putting n = 1 in a general quadrature formula and taking the curve through the limits as a polynomial of degree one so that differences of an order higher than one vanish and one obtains _____ _____

vi) _____ _____ elimination is a variation of Gauss elimination method in which the elements above the major diagonal are eliminated as well as the elements below the major diagonal.

2. Attempt the following : **14**

i) Find a real root of the equation $3x + \sin x - e^x = 0$ by the method of false position correct to four decimal places. **5**

ii) Discuss the stability of Euler's method for solving the differential equations. **5**

iii) Derive the normal equations for fitting the curve $2^x = ax^2 + bx + c$. **4**

3. A) Using Euler's modified method, obtain a solution of the equation

$\frac{dy}{dx} = x + \left|\sqrt{y}\right| = f(x, y)$ with initial condition y = 1 at x = 0 for the range $0 \le x \le 0.6$ in steps of 0.2. **10**

B) Why Monto-Carlo method is advantageous over other methods used for finding the integration ? Explain. **4**

4. A) The values of e^{-x} at x = 1.72 to x = 1.76 are given in the following table :

x	1.72	1.73	1.74	1.75	1.76
$\mathbf{e^{-x}}$	0.17907	0.17728	0.17552	0.17377	0.17204

Find the value of $e^{-1.7425}$ using Newton's forward difference formula. **10**

B) Using Jacobi's iterative method, solve the following simultaneous equations : **4**

$-2x + 3y + z = 9, \quad 3x + 4y - 5z = 0, \quad x - 2y + z = -4$

5. A) Explain the method of least square principle for fitting a power function : $y = ax^c$. **6**

B) Using Newton-Raphson method, find the real root of the equation : $3x = \cos x + 1$, correct to five decimal places. **8**

6. A) Large prime numbers a and b are required to generate a set of pseudo random numbers. Explain it. **6**

B) Using Gauss-Seidal iterative method, solve the following simultaneous equations : **8**

$a + b + c = 2, \quad 5a + 3b + c = 3, \quad 2a + 3b + z = -1$

7. A) Solve the following differential equation : **6**

$$\frac{dy}{dx} = y + x$$

given that y(0) = 1 using Runge-Kutta method for y(0.2) in two steps.

B) Derive Lagrange's interpolation formula for the following data : **8**

x	– 1	0	2	3
y	– 8	3	1	12

Also find Y at x = 1.

———————

SLR-VH – 2

Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2014
MATERIAL SCIENCE (Physics) (Paper – II)
Condensed Matter Physics

Day and Date : Wednesday, 23-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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) Number of atoms present in unit area of (0 1 0) plane of simple cubic crystal are

a) $1/2r^2$ b) $1/6r$ c) $1/4r^2$ d) $1/8r$

2) Diffraction of crystal is possible only when

a) $n\lambda > 2d$ b) $n\lambda < 2d$

c) $n\lambda \leq 2d$ d) $n\lambda \geq 2d$

3) Width of energy gap of superconductor at 0 K is

a) 0 b) $3.5\ K_B Tc$

c) $K_B Tc$ d) 3.5

4) Specific heat of superconductor shows abrupt change at the temperature

a) 0 b) $<T_C$ c) $>T_C$ d) = Tc

5) Penetration depth (λ) is given by the relation

a) $\frac{\lambda_0}{(1-t^2)}$ b) $\frac{\lambda}{(1-t^2)}$

c) $\frac{\lambda}{(1-t^4)}$ d) $\frac{\lambda_0}{(1-t^4)}$

P.T.O.

6) At Curie temperature, the spontaneous magnetization for ferromagnetic material is

a) 0 b) infinite

c) –1 d) +1

7) Elemental solid dielectric have only

a) electronic polarization

b) ionic polarization

c) orientational polarization

d) all polarizations

8) Relative permittivity (ε_r) of the air is

a) 2 b) 0.5 c) 1 d) 0

B) State **true** of **false** : **6**

1) The addition of tri valent impurity creates n-type semiconductor.

2) At Curie temperature spontaneous magnetization is maximum.

3) Ewald sphere is drown with a radius $\frac{1}{\lambda}$.

4) FCC structure contains the contribution of six atoms.

5) Extrinsic semiconductor is the natural semiconductor.

6) Rectifier rectifies internal resistance.

2. Attempt following : **14**

1) Define the terms :

1) Unit cell

2) Coordination number

3) Packing fraction. **5**

2) Absence of fivefold symmetry. **5**

3) Cooper pair. **4**

3. a) What is superconductor ? Discuss London theory in detail. **10**

   b) Meissner's effect. **4**

4. a) What is dielectric polarization ? Give the expression for electronic polarizability. **10**

   b) Calculate the electronic polarizability of an isolated Se atom. The atomic radius of Se atom is 0.12 nm. **4**

5. a) What is Miller indices ? Give the expression for inter planner spacing. **10**

   b) Write the relation for Fermi level in n-type semiconductor. **4**

6. a) Give the theory regarding the calculation of energy gap in intrinsic semiconductor. **10**

   b) Calculate critical current (I_c) flowing through long superconducting wire of diameter 10^{-3} m in the absence of applied field. Given Hc = 7.9×10^3 A/m. **4**

7. a) What is ferromagnetic material ? Explain Weiss molecular theory of ferromagnetisms. **10**

   b) Show that superconductor is diamagnetic below critical temperature. **4**

SLR-VH – 3

Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2014
PHYSICS (Materials Science)
Paper – III : Analog and Digital Electronics

Day and Date : Friday, 25-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 p.m.

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

1. a) Select correct alternative : **14**

1) Slew rate of an ideal opamp is **8**

a) Infinite b) Very high

c) Low d) Very low

2) In the differential circuit, which of the following terminals are connected together ?

a) Bases b) Collector

c) One base to another collector d) Emitters

3) The minimum number of FLIP-FLOPS required for a synchronous decade counter is _____

a) 1 b) 2

c) 4 d) 10

4) In order to startup, a feedback oscillator requires

a) Negative feedback less than one

b) Positive feedback greater than one

c) Unity feedback equal to one

d) No feedback

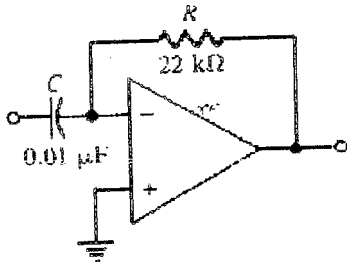
P.T.O.

5) The Boolean expression : $B \cdot (A + B) + A \cdot (\overline{B} + A)$ can be realized using minimum number of

a) One AND gate b) Two AND gates

c) One OR gate d) Two OR gates

6) Refer to the given circuit. This circuit is known as



a) a non inverting amplifier b) a differentiator

c) an integrator d) a summing amplifier

7) Why 8085 processor is called an 8 bit processor

a) Because 8085 processor has 8 bit ALU

b) Because 8085 processor has 8 bit data bus

c) Because speed of 8085 processor depend on data bus width

d) Both a) and b)

8) What does microprocessor speed depends on

a) Clock b) Data bus width

c) Address bus width d) Size of register

b) Fill in the blanks/States **True** or **False** : **6**

i) An SR flip-flop does not accept the input entry both input at one.

ii) The AND operation can be produced with three NAND gates.

iii) A modulus-12 counter must have 4 flip-flops.

iv) When an op-amp is operated in a single ended mode one input is grounded.

v) ROM is a volatile memory.

vi) The device used to convert a binary number to a 7 – segment display format is Decoder.

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

   1) Phase shift oscillator.

   2) Voltage follower.

   3) Switching voltage regulator

   4) Shift registers.

3. a) Explain the operation of Weign Bridge Oscillator with suitable circuit diagram. **8**

   b) What is multiplexer and de-multiplexer. Explain with illustrative examples. **6**

4. a) Explain the circuit for a three op-amp instrumentation amplifier and obtain the expressions for output voltage for a given input voltages and resistance value. **8**

   b) Explain the transistor as a switch. **6**

5. a) Explain about JK Flip-Flop with proper diagram. **8**

   b) Describe square and triangle wave generators. **6**

6. a) Explain the circuit and timing diagram of synchronous counters. What advantages do synchronous counters have over asynchronous counters ? **8**

   b) Explain LC tunable oscillator. **6**

7. a) Draw the functional block diagram of 8085 microprocessor and explain it. **8**

   b) Assume that the accumulator contents data bytes 88 hand instruction MOV C, A 4FH is fetched. List the steps decoding and executing the instructions. **6**

SLR-VH – 5

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2014
MATERIAL SCIENCE (Physics)
Statistical Mechanics (Paper – V)

Day and Date : Tuesday, 22-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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) Choose the correct alternative : **8**

1) How many calories of heat are required to raise the temperature of 3 kg of aluminum from 20°C to 55°C ? Given specific heat capacity of aluminum C = 910J $kg^{-1}K^{-1}$ and 4.2J = 1 calorie.

a) 13000 b) 22750 c) 35750 d) 95550

2) Which of the statements below is wrong about an ideal gas ?

a) The total number of molecules is large

b) The molecules are in random motion

c) The molecules do not exert any appreciable force on one another or on the walls

d) The volume of the molecule is negligibly small compared with the volume occupied by the gas

3) When ice melts ?

a) a phase change occurs from a solid phase to liquid phase

b) an endothermic process occurs which requires energy

c) the water changes from a crystalline solid to a liquid

d) all of the above

P.T.O.

4) The first order phase transitions are accompanied by a discontinuous change in _____
   a) Gibb's molar free energy function
   b) Internal energy
   c) Crystal symmetry
   d) None of the above

5) The ration of Universal gas constant and Avogadro's number is called
   a) Boltzmann's constant b) Equilibrium constant
   c) Velocity constant d) Maxwell coefficient

6) The phase space is _____ dimensional space.
   a) 3N b) 6N c) N d) 2N

7) The chemical potential for photon gas is
   a) Greater than Zero b) Less than Zero
   c) Equal to Zero d) Not defined

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

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

1) In solids the molecules have no motion and no energy. (True/False)
2) Closed isolated system is an example of _____ ensemble.
3) The classical results are valid only at high temperature. (True/False)
4) It is possible to calculate the transport properties of gases from the law of corresponding states. (True/False)
5) When the order parameter changes _____ oat the transition, the transition is first order.
6) The transition from liquid He I to He II is called _____ transition.

2. Attempt **any three** : **14**

   a) Show that the energy of universe is constant and the entropy of the universe tends to a maximum.

   b) Explain the concept of Phase space.

   c) Find the second viral coefficient of anharmonic oscillator with potential energy $V(x) = (1/2)\ (\alpha x^2 + \gamma x^4)$.

   d) Distinguish between 1^{st} order and 2^{nd} order phase transition.

3. A) Derive Plank's formula for black body radiation using Bose-Einstein statistics. **10**

   B) Explain the concept of density matrix in quantum statistical mechanics. **4**

4. A) Derive partitions function for canonical ensemble. **10**

   B) Explain the concept of Gibb's paradox. How it can be removed ? **4**

5. A) Show that during the first order phase transition, the Gibb's function is continuous, but the first derivative of the Gibb's function changes discontinuously. **10**

   B) Distinguish between classical and quantum statistical mechanics. **4**

6. A) Express the equation of state of a hard sphere gas in the viral form including Terms upto the third viral coefficient. **10**

   B) Derive Ehrenfest's equation for second order phase transition. **4**

7. A) Establish Fokkr-Planck equation and solve it. Discuss how this equation leads to the state of equilibrium. **10**

   B) Discuss the fluctuations in grand canonical ensemble. **4**

SLR-VH – 6

Seat No.	

M.Sc. (Part – I) (Sem. – II) Examination, 2014
MATERIALS SCIENCE (Physics)
Paper – VI : Quantum Mechanics

Day and Date : Thursday, 24-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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. A) Choose correct alternatives : **8**

1) Hermitian matrices have
   a) real eigenvalues b) complex eigenvalues
   c) no eigenvalues d) zero eigenvalues

2) If $\delta(x)$ is a Dirac delta function, the $\delta(a, x)$ is equivalent to
   a) $|a| \cdot \delta(x)$ b) $1/|a| \cdot \delta(x)$
   c) 0 d) a

3) Conservation of probability is guaranteed by demanding that the operators are
   a) hermitian b) orthogonal
   c) represented by square matrices d) unitary

4) Hooks law gives the expression for force as
   a) F = – dV/dx b) F = m a
   c) F = – k x d) None of the above

5) Compared to the electron with a higher angular momentum, the electron having lower angular momentum is
   a) Away from the nucleus b) Nearer the nucleus
   c) Has a thicker orbital d) None of the above

P.T.O.

6) The no. of electrons circulating about the positively charged nucleus in a hydrogenlike atom is
   a) Equal to the number of protons in the nucleus
   b) Equal to mass number
   c) Negligible
   d) One
7) In atoms having many electrons, the electron repulsion term
   a) can be ignored
   b) can be included in the momentum operator
   c) has to be included in the potential energy term of wave equation
   d) none of the above
8) The Born-Oppenheimer approximation is valid for
   a) The ground electronic state of the molecule
   b) The excited electronic state of the molecule
   c) Both the above
   d) None of the above

B) Fill in the gaps :
1) The wave associated with a particle is called _____ wave. **3**
2) The Heisenberg's Uncertainty relation involving energy E is _____
3) The determinantal form of the wavefunction of a many electron system is known as _____ determinant.

C) State **true** or **false** : **3**
1) For bound states, Ψ must vanish at infinity.
2) A hermitian operator conserves probability.
3) The exact solution of a many-electron is not obtained.

2. Attempt **any three** : **14**

a) What are commuting operators ? Show that the commutating operators have simultaneous eigen functions.

b) Discuss the phenomenon showing particle nature of light. What is wave-particle duality ?

c) State and explain the second postulate of quantum mechanics.

d) Write a note on many electron atoms.

3. a) Considering the de Broglie wave associated with a moving particle, derive Schrodinger equation. Generalize it to three dimensions. How would interpret the wave function Ψ ? **10**

   b) When X-rays of wavelength 1.5 $\mathring{A}$ are allowed to hit an atom they eject an inner electron which moves after collision with the velocity of 2.14×10^9 cm/s. Find the binding energy of that electron in the atom ? **4**

4. a) What is an operator ? Discuss properties of operators in quantum mechanics. What are hermitian and unitary operators ? **10**

   b) Calculate the zero-point energy of a mass of 1.67×10^{-24} gm connected to a fixed point by a spring with a force constant of 10^4 dyne/cm. **4**

5. a) How would you write and process the Schrodinger equation for a Hydrogenlike atom ? What are spherical harmonics ? Obtain the expression for energy levels. **10**

   b) How would you explain color of a physical system ? Why some transitions between energy levels are forbidden ? **4**

6. a) What do you understand by space quantization of Electronic orbits ? Why is it called so ? Why m is called magnetic quantum number ? **10**

   b) Show that a closed shell electron configuration is always represented by ^1S term. **4**

7. a) Apply the Born-Oppenheimer approximation and the LCAO molecular orbital theory to the Hydrogen molecule ion. **10**

   b) Obtain the term symbol for the ground state of the nitrogen atom assuming the Russell-Saunders coupling. **4**

SLR-VH – 7

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2014
MATERIALS SCIENCE (Physics) (Paper – VII)
Physical Chemistry

Day and Date : Saturday, 26-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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. a) Select correct alternatives. **14**

i) If ΔC_v is found to be positive, it show that **8**

a) ΔE increases with increase in temperature

b) ΔE decreases with decrease in temperature

c) ΔC_v is independent of temperature

d) None of these

ii) The vigorous reaction that takes place when sodium reacts with water is

a) Exothermic b) Hydrolysis

c) Endothermic d) Neutralisation

iii) The solution of electroly in water, when electrolysed liberate H_2 at cathode and Cl_2 at anode, the electrolyte must be

a) H_2SO_4 b) $CuCl_2$ c) NaCl d) Na_2SO_4

iv) An expression $E_C = E_C^{\circ} - \frac{RT}{nF} \ln Q_a$, is called

a) Van't Hoff equation b) Nernst equation

c) Both a & b d) None of these

P.T.O.

v) The velocity constant of third order reaction is expressed in

a) sec^{-1} b) $dm^3.mol^{-1}.sec^{-1}$

c) $mol^{-2}.(dm^3)^2.sec^{-1}$ d) min^{-1}

vi) Reaction in which three reactant molecules take part are called _____ reactions.

a) termolecular b) bimolecular

c) unimolecular d) none of these

vii) Enthalpy of reaction is defined as

a) H = E – PV b) H = E + PV

c) E + PV = –H d) E – PV = –H

viii) The colloidal particles can form cluster together is

a) Micelle b) Surfactant

c) Colloid d) None of these

b) Fill in the blanks/state **true** or **false**. **6**

i) The equation, $K = \frac{1}{2t}\left[\frac{x(2a-x)}{a^2(a-x)^2}\right]$ represents the expression for rate constant of a third order reaction when all reactants are at the same.

ii) The equation, $\overline{V}_i = \left(\frac{\partial v}{\partial n_i}\right)_{P,T,n_j}$ represents

iii) The escaping tendency of a substance from one state to another is

iv) $2\,HI \rightarrow H_2 + I_2$, is an example of _____ order reaction.

v) The discharge potential is defined as the potential at which the continuous discharge of ions commences at that electrode. (True/False)

vi) To determine excess volume calorimeter can be used. (True/False)

2. Attempt the following. **14**

i) Derive, $C_p - C_V = R$. Define the terms involved in the equation. **5**

ii) Deduce an expression for second law of thermodynamics. **5**

iii) What are colloids and surfactants ? **4**

3. a) Explain in detail the effect of ionic strength on the rate of reaction. **10**

   b) Write a note on Entropy and give its SI Unit. **4**

4. a) What is partial molar entropy and how it can be determined by colorimetry ? **10**

   b) Explain corrosion. How corrosion can be controlled ? **4**

5. a) Explain the RRKM theory of unimolecular reaction rate. **10**

   b) Discuss fugacity and activity. **4**

6. a) What are concentration cells ? Give its different types and explain one of them in detail. **10**

   b) Differentiate between order and molecularity of reaction. **4**

7. a) What is decomposition potential ? How it can be determined experimentally ? **10**

   b) Solubility of barium carbonate is 8.944×10^{-5} moles/dm^3 at 298 K. Calculate solubility product at the same temp. **4**

SLR-VH – 8

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2014
MATERIALS SCIENCE (Physics) (Paper – VIII)
Analytical Techniques – II

Day and Date : Tuesday, 29-4-2014 Total Marks : 70
Time : 11.00 a.m. to 2.00 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.*

14

1. A) Choose correct alternatives. **8**

i) The range of Far IR is _____
   a) 0.025 – 0.5 mm b) 0.25 – 5 mm
   c) 0.25 – 0.5 mm d) 0.025 – 5 mm

ii) SPM scans are made over few _____ in horizontal plane (x – y).
   a) nm to 100 μm b) nm to 10 μm
   c) nm to 1000 μm d) nm to 1 μm

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

iv) _____ cantilever have spring constant of about 0.1 N/m.
   a) SEM b) MFM c) AFM d) SPM

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

vi) Elastic scattering of a photon is known as _____ scattering.
   a) Rayleigh b) Antistokes
   c) Raman d) Stokes

P.T.O.

vii) In case of orthorhombic crystal system _____

a) $a = b \neq c$ b) $a \neq b \neq c$ c) $a = b = c$ d) $a \neq b = c$

viii) In XPS, photoelectrons are produced using _____

a) X-rays b) β-rays c) γ-rays d) α-rays

B) Fill in gaps : **6**

i) An _____ is any frequency higher than the fundamental frequency of a sound.

ii) Free electron states have _____ potential energy.

iii) The coordination number of hcp structure is _____

iv) _____ is a collective excitation in a periodic, elastic arrangement of atoms or molecules in condensed matter.

v) The _____ shift is the resonant frequency of a nucleus.

vi) The _____ system is called as trigonal.

2. Attempt **any three** : **14**

1) Write a note on detectors of X-rays.

2) Explain the term WDS.

3) How particle size has been calculated using X-ray diffractograms.

4) Describe magnetic force microscope.

3. a) Describe basic principle, working and applications of the Raman spectroscopy. **10**

b) Give the difference between stokes and antistokes scattering. **4**

4. a) Describe basic principle, instrumentation and applications scanning probe electron spectroscopy. **10**

b) Show basic unit cell, define vectors a, b, c or (a1, a2, a3) and angles α, β, γ. **4**

5. a) How we can determine lattice parameters and crystal structure in monoclinic system ? **10**

b) Explain the term attenuated total reflection. **4**

6. a) Describe basic principle, working and applications of UPS. **10**

b) Interpret data interpretation and analysis in FTIR spectroscopy. **4**

7. a) How we can calculate chemical shift, quantification, and depth-profiling using XPS ? **10**

b) Give the applications of SEM. **4**

_____

SLR-VH – 9

Seat No.	

M.Sc. – II (Semester – III) Examination, 2014
PHYSICS (Materials Science)
Semiconductor Devices (Paper – IX)

Day and Date : Monday, 21-4-2014 Max. Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions *: 1) Attempt* ***any 5*** *questions.*
2) Q. ***1*** *and Q.* ***2*** *are* ***compulsory****.*
3) Attempt ***any 3*** *from Q.* ***3*** *to Q.* ***7****.*
4) ***Use*** *of calculators is* ***allowed****.*

1. Objective questions (Choose the correct alternative) : **14**

1) The forced β of a BJT is given by _____

a) $\frac{I_{c(sat)}}{I_b}$ b) $\frac{I_{e(sat)}}{I_b}$ c) $\frac{I_b}{I_{b(sat)}}$ d) $\frac{I_b}{I_{c(sat)}}$

2) Power MOSFET's are _____ controlled devices.

a) Power b) Voltage
c) Current d) Both a) and b)

3) In order to achieve flat band condition, surface potential (ψ_s) must be _____

a) Zero b) Negative
c) Positive d) Excessively positive

4) The maximum sensitivity of the eye is at _____ μm.

a) 0.500 b) 0.555
c) 0.520 d) 0.700

5) The dominating operating process for LED is _____

a) Spontaneous emission b) Stimulated emission
c) Absorption d) Reflection

P.T.O.

6) In a CCD, charge transfer efficiencies larger than 99.99% can be obtained in the presence of _____
   a) Self induced drift
   b) Density of interface states
   c) Fringing field
   d) Thermal diffusion

7) Enhancement type MOSFET's respond only to _____ V_{GS}.
   a) Negative
   b) Positive
   c) Both a) and b)
   d) No voltage needed

8) CMOS technology implies _____ technology.
   a) n-channel depletion
   b) p-channel depletion
   c) only channel enhancement
   d) both a) and b)

9) In MIS diode, the ON-set of strong inversion occurs at _____
   a) $\psi_S = 0$
   b) $\psi_S = \psi_B$
   c) $\psi_S = 2\psi_B$
   d) $\psi_S = \frac{1}{\psi_B}$

10) In a buried channel CCD, storage and transfer of the charge packet takes place _____
   a) Through the bulk of the semiconductor
   b) Along the surface of the semiconductor
   c) Both a) and b)
   d) None of the above

11) If the bottom of the conduction band is located at _____, it is called Γ-Point.
   a) $K = \pi$
   b) $K = 0$
   c) $K = -\pi$
   d) $K = 2\pi$

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

13) Tunnel diode exhibits _____ controlled NDR.
   a) Current
   b) Voltage
   c) Power
   d) None of the above

14) Resonant tunneling diode has a cut-off frequency in the _____ range.
   a) KHz
   b) MHz
   c) GHz
   d) THz

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

   1) The modern MOSFET's are fabricated on $\langle 100 \rangle$ oriented Si – – Comment. **5**

   2) Visible LED's. **5**

   3) Triac. **4**

3. a) With constructional details, explain the complex I-V characteristic of an SCR. **10**

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

4. a) Sketch and explain a basic 3-phase CCD and discuss how a charge packet is transferred along the surface of a continuous substrate. **9**

   b) Discuss the I-V characteristic of a tunnel diode. **5**

5. a) Discuss with an energy band diagram and equivalent circuit, the pn-junction solar cell referred to open circuit voltage (V_{OC}), short circuit current (I_{SC}), maximum power output (Pm) and conversion efficiency (η). **10**

   b) Write a note on organic LED's. **4**

6. a) Discuss and compare transferred electron effect in GaAs and InP. **10**

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

7. a) Discuss the potential-well model for the charge storage system. **10**

   b) What are $\frac{dV}{dt}$ and $\frac{dI}{dt}$ effects ? **4**
