SLR-HP – 373

Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Materials Science) (New)
(Paper – I)
Mathematical Techniques

Day and Date : Wednesday, 15-4-2015 Max. Marks : 70
Time : 11.00 a.m. to 2.00 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. a) Choose the correct alternative : **6**

i) The value of the $\int_c \frac{dz}{z+2} c : |z| = 1$ is

A) $2\pi i$ B) $-2\pi i$ C) $4\pi i$ D) 0

ii) Both real and imaginary parts of an analytic functions are

A) Harmonic B) Non-Harmonic
C) Homomorphic D) Continuous

iii) The eigen values of the matrix $\begin{pmatrix} 4 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 1 \end{pmatrix}^{-1}$ are

A) 4, 3,1 B) – 4, – 3, –1 C) 1/4, 1/3, 1 D) 4, 3, 0

iv) The laplace inverse of $\frac{1}{s^2+4}$ is

A) cos 2t B) $\frac{1}{2}$ cos 2t C) sin 2t D) $\frac{1}{2}$ sin 2t

v) The Fourier Transform of $e^{-x^2/2}$ is

A) $e^{s^2/2}$ B) $e^{-s/2}$ C) $e^{s/2}$ D) $e^{-s^2/2}$

vi) The Fourier series of x^2 in $(-\pi, \pi)$ will involve _____ terms.

A) only cosine terms
B) constants
C) both sine and cosine terms
D) only sine terms

b) State **true** of **false**.

i) The value of $f'(z)$ for an analytic function f (z) = u + iv is $u_x + iv_x$. **8**

ii) If f (z) is analytic function and on the closed curve C, if a is any point within C, the $\frac{1}{2\pi i}\int_C \frac{f(z)dz}{z-a} = f(a)$.

iii) Eigen vectors of the matrix are linearly dependent.

iv) The Laplace transform is possible only for t > 0.

v) The Fourier Integral of f (x) is possible only if it satisfy Dirichlet's conditions in each finite interval $(-l, l)$ and it is integrable in $(-\infty, \infty)$.

vi) If a, b, c, are the eigen values corresponding to the matrix A, then the eigen values corresponding to A^n will be a, b, c.

vii) A transformation is said to be linear if it satisfy T (c.x + d.y) = c.T (x) + d. T(y), where c, d are constants.

viii) Fourier series of the function f(x) is defined only if it satisfy Dirichlet's conditions.

2. Write short notes on :

a) Write a note on Vector Spaces. **5**

b) Define Cosine Integral and Sine Integral of the function f (x). **4**

c) Find Laplace Transform of $\frac{e^{-t}\sin at}{t}$. **5**

3. a) Use Cauchy Integral formula to evaluate $\int_C \frac{3z^2 + z}{z^2 - 1} dz$ where C is the circle $|z-1| = 1$. **8**

   b) Find the eigen values and eigen vectors corresponding to smallest eigen value $\begin{pmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{pmatrix}$. **6**

4. a) Solve $(D^2 - 5D + 6)\, y = \sin 3x$. **8**

   b) Find half range Cosine series of $f(x) = x$ in $[0, 2]$. **6**

5. a) Find the Laplace transform of $\int_0^t ue^{-4u} \sin 5u\, du$. **8**

   b) Show that real and imaginary parts of function $w = \log z$ satisfy the Cauchy Riemann equations when z is not zero. **6**

6. a) $(x^2 D^3 - 3xD + 5)\, y = \sin(\log x)$. **8**

   b) Examine vectors for Linear dependence

   $[1, -1, 0], [2, -1, -2], [1, -1, -2]$. **6**

7. a) Find Fourier series of $f(x) = a^2 - x^2$ in $[-a, a]$. **8**

   b) Find Inverse Laplace transform of $\frac{2s^2 - 4}{(s+1)(s-2)(s-3)}$. **6**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
MATERIALS SCIENCE (PHYSICS)
(Paper – II) (New)
Condensed Matter Physics

Day and Date : Friday, 17-4-2015 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 T =

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

5) Critical current (I) decreases linearly with increase of applied magnetic field is _____ rule.

a) Weiss's b) Silsbee's

c) Lorentz d) Hunt's

6) Penetration depth (λ) is the value of 'x' for which flux density reduces to _____ of its original value.

a) 1/e b) infinite c) o d) e

7) If the ratio of average dipole energy to average thermal energy is _____ then polarization is said to be effective.

a) 1 b) <1 c) >1 d) –1

8) Fermi level in case of n-type semiconductor lies at

a) $E_F = \frac{E_C + E_D}{2}$ b) $E_F = \frac{E_C - E_D}{2}$

c) $= \frac{E_V - E_D}{2}$ d) $E_F = \frac{E_V + E_D}{2}$

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

1) Semiconductor have positive temperature coefficient of resistance.

2) At Curie temperature materials shows normal to superconducting state.

3) Simple cubic unit cell having atomic radius r = a/2.

4) FCC structure contains the contribution of six atoms.

5) Extrinsic semiconductor contains equal number of holes and electrons.

6) The reverse saturation current in silicon diode is nearly 1 nA.

2. Attempt following. **14**

1) Orientational polarization **5**

2) Absence of fivefold symmetry **5**

3) Cooper pair **4**

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

b) Explain 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) Derive rectifier equation. **10**

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

6. a) Write in detail about 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) Explain the behaviour of free electron in periodic potential. **8**

   b) Write about the formation of number of possible states in a band. **6**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Mat. Sci.) (New)
Analog and Digital Electronics (Paper – III)

Day and Date : Monday, 20-4-2015 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. Objective questions : **14**

a) Select correct alternatives : **6**

1) An ideal op-amp has

a) Infinite output impedance b) Infinite band width

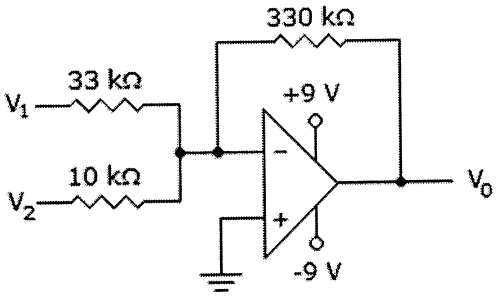
c) Zero input impedance d) All of the above

2) Another name of the unity gain amplifier is

a) Differential amplifier b) Non-inverting amplifier

c) Comparator d) Voltage follower

3) Calculate the output voltage of the following circuit if $V_1 = -0.2$ V and $V_2 = 0$V.



a) 0 V b) – 6.6 V

c) – 4 V d) 2 V

P.T.O.

4) How many Flip-Flops are required for mod – 16 counter ?

a) 5 b) 6

c) 3 d) 4

5) The device which changes from serial data to parallel data is

a) Counter b) Multiplexer

c) Demultiplexer d) Flip-flop

6) Addressing in which the instructions contains the address of the data to the operated on is known as

a) Immediate addressing b) Implied addressing

c) Register addressing d) Direct addressing

b) State **true** or **false**/Justify/**one** line answer : **8**

1) The gain of the non-inverting amplifier is _____

2) An astable multivibrator is also known as a _____

3) What is the resonant frequency equation of Wien bridge oscillator ?

4) The circuit for a DEMUX is basically the same as for a decoder, provided the decoder has an enable input.

5) The memory used in synchronous sequential circuits are flip-flops.

6) Design NOT gate using 1×2 demux ?

7) Program counter is a _____ bit register.

8) Trap is a maskable interrupt.

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

a) Instrumentation Amplifier. **5**

b) Wein bridge oscillator. **5**

c) Multiplication program for two 8-bit numbers in 8085 μp. **4**

3. a) Using inverting configuration of an op-amp, explain i) summing amplifier ii) scaling amplifier and iii) averaging amplifier. **10**

b) Write down the circuit diagram for constant current bias. **4**

4. a) Explain in detail about voltage regulators with neat sketches. **8**

   b) Write a brief note on Astable Multivibrator. **6**

5. a) State Demorgan Theorems with examples. **8**

   b) Explain about the Working of RS flip-flop. **6**

6. a) What do you mean by flip-flops ? Describe the edge triggered flip-flops. Convert SR flip-flops into JK flip-flops. **8**

   b) Draw and explain the working of 4-bit up and down synchronous counter. Also describe the working of shift register. **6**

7. a) Explain in detail about the Architectural features of 8085 microprocessor with the help of neat diagrams. **8**

   b) What is an addressing mode ? Write about the addressing modes of 8085 microprocessor with examples. **6**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Materials Science)
Paper No. – IV : Classical Mechanics (New)

Day and Date : Wednesday, 22-4-2015 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. Objective questions : **14**

a) Choose correct alternative : **8**

1) A bead is constrained to slide on a frictionless rod that is fixed at an angle θ with a vertical axis and is rotating with angular frequency ω about the axis. Taking the distance s along the rod as a variable, the Lagrangian for the bead is equal to

a) $\frac{1}{2}m\dot{s}^2 - mgs\cos\theta$

b) $\frac{1}{2}m\dot{s}^2 + \frac{1}{2}m\,(\omega s\cos\theta)^2 + mgs\cos\theta$

c) $\frac{1}{2}m\dot{s}^2 + mgs\cos\theta$

d) $\frac{1}{2}m\dot{s}^2 + \frac{1}{2}m\,(\omega s\sin\theta)^2 - mgs\cos\theta$

2) A particle of mass m moves in a 1 – D potential $V(x) = -ax^2 + bx^4$, where a and b are positive constants. The angular frequency of small oscillations about the minima of the potential is equal to

a) $\pi\,(a/m)^{1/2}$ b) $(a/mb)^{1/2}$

c) $2\,(a/m)^{1/2}$ d) $(a/2m)^{1/2}$

P.T.O.

3) The curvature of Mars is such that its surface drops a vertical distance of 2.0 m for every 3600 m tangent to the surface. In addition, the gravitational acceleration near its surface is 0.4 times that near the surface of earth. What is the speed of the golf ball would need to orbit Mars near the surface, ignoring the effects of air resistance ? (Radius of Mars ~ 8×10^6 m).

a) 0.9 km/s
b) 1.8 km/s
c) 3.6 km/s
d) 4.5 km/s

4) A sphere of mass m is released from rest in a stationary viscous medium. In addition to the gravitational force of magnitude mg, the sphere experiences a retarding force of magnitude bv, where v is the speed of the sphere and b is a constant. Assume that the buoyant force is negligible. Which of the following statements about the sphere is true ?

a) Its KE decreases due to retarding force
b) Its KE increases to maximum and decreases to zero due to retarding force
c) Its speed increases monotonically, approaching a terminal speed that depends on b but not on m
d) Its speed increases monotonically, approaching a terminal speed that depends on both b and m

5) A man of mass m on an initially stationary boat gets off the boat by leaping to the left in an exactly horizontal direction. Immediately after the leap, the boat of mass M, is observed to be moving to the right at speed v. How much work did the man do during the leap (both on his body and on the boat) ?

a) $\frac{1}{2}Mv^2$
b) $\frac{1}{2}mv^2$
c) $\frac{1}{2}(m+M)v^2$
d) $\frac{1}{2}\left(M+\frac{M^2}{m}\right)v^2$

6) A particle of unit mass undergoes 1-D motion such that its velocity varies according to $v(x) = \beta x^{-n}$, where β and n are constant and x is the position of the particle. What is the acceleration of the particle as a function of x ?

a) $-n\beta^2 x^{-2n-1}$
b) $-n\beta^2 x^{-n-1}$
c) $-n\beta^2 x^{-n}$
d) zero

7) A ball is dropped from a height h. As it bounces off the floor, its speed is 80 % of what it was just before it hit the floor. The ball will then rise to a height of most nearly

a) 0.94 h b) 0.80 h

c) 0.75 h d) 0.64 h

8) The term monogenic indicates all forces are

a) generated from a single function (potential) and potential is an explit function of position coordinates only

b) generated from a single function (potential) and potential is an explit function of position and time coordinates

c) generated from a multiple function (potential) and potential is an explit function of position coordinates only

d) none of the above

b) **True / false** : **6**

1) Stationary value for a line integral mean that the integral along the given path has the same value to within 1^{st} order infinitesimals as that along all neighborings paths.

2) Number of Generalized coordinates are greater than number of degrees of freedom.

3) Poisson Bracket are invariant under canonical transformations.

4) Holonomic constraints cannot be expressed as an algebraic equation.

5) In any virtual displacement, the total work done by the forces of constraint vanish, unless of course the constraint is associated with frictional forces.

6) If the system is invariant under translation along a given direction then corresponding linear momentum is conserved.

2. Write short answer : **14**

a) Show that the Newton's laws are invariant under Galilean transformation. **5**

b) Explain the motion of Gyroscope. **5**

c) Show that the total linear momentum of the system as measured from centre of mass coordinate system is zero. **4**

3. a) Derive Lagrange's equation of motion for a partly conservative system. **10**

   b) What is Hamiltonian (H) ? Discuss. **4**

4. a) Obtain Euler – Lagrange differential equation. **8**

   b) Write a note on variational principle. **6**

5. a) What is Canonical transformations ? Explain in detail what conditions a transformation can satisfied to be called canonical transformation. **8**

   b) Show that $P = \frac{1}{2}\left(p^2 + q^2\right)$ and $Q = \tan^{-1} q/p$ is a canonical. **6**

6. a) State and explain Kepler's laws of planetary motion. Derive 2^{nd} Kepler's law. **8**

   b) Discuss principle of least action. **6**

7. a) Show that Poisson bracket are invariant under canonical transformations. **8**

   b) What are constraints ? State and explain all types of constraints with one example of each case. **6**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Materials Science)
Paper No. – I : Mathematical Techniques (Old)

Day and Date : Wednesday, 15-4-2015 Total Marks : 70

Time : 11.00 a.m. to 2.00 p.m.

Instructions *: 1) Question No.* ***1*** *and* ***2*** *are* ***compulsory****.*
2) Answer ***any three*** *questions from Question No.* ***3*** *to* ***7****.*
3) ***All*** *questions carry* ***equal*** *marks.*

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

1) $xy'' - (2x-1)y' + (x-1)y = 0$ for this differential equation consider the statements (i) it is linear (ii) of second degree, then

a) only (i) is true

b) only (ii) is true

c) both (i) and (ii) are true

d) both (i) and (ii) are false

2) The trace of the matrix $A = \begin{bmatrix} 2 & 4 \\ 3 & 7 \end{bmatrix}$ is

a) -7 b) 9 c) 2 d) 14

3) The function $f(z) = \dfrac{z^2 - 3z + 4}{z - 3}$ has a simple pole at $Z =$ _____

a) ∞ b) 3 c) 1 d) 2

4) For a square matrix, conjugate transpose of which coincide with the matrix itself is called

a) Unitary b) Hermitian

c) Orthogonal d) Skew Hermitian

P.T.O.

5) For a function to have Fourier series expansion necessary conditions are
   a) f(x) and its integrals are finite
   b) f(x) and its integrals are single valued
   c) f(x) has discontinuities finite in nature and number
   d) all the above

6) Laplace Transform of the function f(t) = sinh2t is = _____

a) $\frac{s}{s^2+2}$ b) $\frac{2}{s^2+4}$ c) $\frac{2}{s^2-4}$ d) $\frac{s}{s^2-4}$

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

1) The Laplace's transform of f(t) = t is $1/S^2$.
2) The Eigen values of Hermitian matrix are real.
3) Inverse Laplace Transform of $\frac{3}{(s-2)^2}$ is $\frac{1}{3}e^{-2t}t$.
4) $\begin{bmatrix} 3 & 9 \\ -2 & 6 \end{bmatrix}$ is a singular matrix.
5) $f(z) = \frac{\sin z}{z^4}$ has a pole of order 4 at z = 0.
6) $AA^T = I$ then A is said to be orthogonal.
7) The differential equation $(x^2 - 4xy - 2y^2)\,dx + (y^2 - 4xy - 2x^2)\,dy = 0$ is not an exact differential equation.
8) Term by term integration of a convergent Fourier series is not valid.

2. Attempt the following :

a) Show that $A = \begin{bmatrix} -3 & 2 \\ -2 & 1 \end{bmatrix}$ is not diagonalizable.

b) Define a pole. Find the pole and its order for $f(z) = \frac{\sin z}{z^4}$.

c) Define Laplace transform. Derive Laplace Transform of the functions (i) f(t) = e^{at} (ii) f(t) = sin at. **(5+5+4)**

3. a) Using Residue Theorem evaluate $\int_0^{2\pi} \frac{d\theta}{5+4\cos\theta}$.

   b) Find Eigen values and corresponding Eigen vectors for the matrix.

$$A = \begin{bmatrix} 3 & 4 & -6 \\ 4 & 3 & -6 \\ -6 & -6 & -14 \end{bmatrix}$$

(6+8)

4. a) Find a matrix S that diagonalizes $A = \begin{bmatrix} 3 & -2 & 0 \\ -2 & 3 & 0 \\ 0 & 0 & 5 \end{bmatrix}$.

   b) Solve :

   i) $\frac{d^2y}{dx^2} + 9y = x \sin x$

   ii) Find the solution of $\frac{d^2y}{dx^2} + y = 0$, satisfying y(0) = 1 and $y\left(\frac{\pi}{2}\right) = 2$. **(8+6)**

5. a) Expand the function f(x) = sin x for $0 \le x \le \pi$.

   f(x) = – sin x for $-\pi \le x \le 0$ in Fourier series and draw the waveform.

   b) Find the Fourier transform F(K) of the Gaussian distribution function

   $f(t) = N e^{-at^2}$ where N and 'a' are constants. **(8+6)**

6. a) Obtain Laplace Transform of $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 4y + 2\int_0^t y(t)\,dt$.

   b) Using Partial fractions find Inverse Laplace Transform of

   i) $\frac{21s - 33}{(s+1)(s-2)^3}$

   ii) Find Inverse Laplace transform of $\frac{2s+1}{s(s+1)}$. **(6+8)**

7. a) Express general form of first order ODE and solution y(t). What do you mean by boundary conditions ? Thus explain Euler's method to numerically solve the ODE.

   b) Classify the singularities and calculate residue for $f(z) = \frac{1}{z^2 - 1}$. **(10+4)**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Material Science) (Old) (Paper – II)
Condensed Matter Physics

Day and Date : Friday, 17-4-2015 Total Marks : 70
Time : 11.00 a.m. to 2.00 p.m.

Instructions *: 1) Questions* ***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 the correct alternative. **8**

1) The distribution of electrons in the conduction band is given by
   i) (density of quantum states) × (energy of a state)
   ii) (density of quantum states) × (probability a state is occupied)
   iii) (energy of quantum states) × (probability a state is occupied)
   iv) (energy of quantum states) × (chemical potential of a state)

2) A plane intercepts at (a, b/2, 3c) in a simple cubic unit cell. The Miller indices of the plane are
   i) [1 3 2] ii) [2 6 1]
   iii) [3 6 1] iv) [1 2 3]

3) A beam of X-ray of wavelength 0.25 nm is incident on a crystal of interplanar separation 0.30 nm. The glancing angle for first order diffraction is
   i) 24.6° ii) 36.0°
   iii) 56.4° iv) 54.8°

4) The nearest neighbour distance in the case of bcc structure is
   i) $\frac{a\sqrt{3}}{2}$ ii) $\frac{a}{\sqrt{2}}$
   iii) $\frac{2a}{\sqrt{3}}$ iv) $\sqrt{2}a$

P.T.O.

5) The order of magnitude of the energy gap of a typical superconductor is

i) 1 MeV ii) 1 KeV

iii) 1 eV iv) 1 meV

6) The equation of motion of each electron in the Fermi surface under the influence of a static electric field E is

i) $\hbar\frac{dK}{dt} = Ee$ ii) $\hbar\frac{dK}{dt} = \frac{E}{e}$

iii) $\hbar\frac{dK}{dt} = Ee^2$ iv) $\hbar\frac{dK}{dt} = \frac{e}{E}$

7) Meissner effect implies that in superconducting state, a material has a magnetic susceptibility equal to

i) $\chi = 0$ ii) $\chi = -1$

iii) $\chi = 1$ iv) $\chi = \infty$

8) A lattice is characterized by following primitive vectors $\vec{a} = 2(\hat{i} + \hat{j}), \vec{b} = 2(\vec{j} + \hat{k}), \vec{c} = 2(\hat{k} + \hat{i})$. The reciprocal lattice corresponding to this lattice is

i) bcc with cube edge π

ii) bcc with cube edge 2π

iii) fcc with cube edge π

iv) fcc with cube edge 2π

b) Fill in the gaps with appropriate word. **6**

i) For a given dielectric, the electronic polarizability (α_e) is _____ by temperature change.

ii) The depletion region in an open circuited p-n junction contains _____

iii) The width of the energy gap of a superconductor at 0 K is about _____

iv) The number of ions in the unit cell of CsCl crystal is _____

v) The Miller indices of the plane parallel to y and z axes are _____

vi) Relative permeability of a medium is the permeability relative to that of _____

2. a) Attempt **any two** of the followings : **8**
   i) Explain direct and indirect band gaps in semiconductors.
   ii) Show that the polarizability (α) of a conducting metallic sphere of radius 'a' is $\alpha = a^3$.
   iii) What is the dipole theory of Ferro electricity ?

   b) Attempt **any one** of the followings : **6**
   i) What is Meissner effect ? Obtain an expression for the London penetration depth of magnetic field for a superconductor.
   ii) A magnetic material has a magnetization of 3300 A/m and flux density of 0.0044 Wb/m^2. Calculate the magnetizing force and the relative permeability of a material.

3. a) Write short notes on the followings : **8**
   i) Reciprocal lattice
   ii) Metal-semiconductor contacts.

   b) What are intrinsic and extrinsic semiconductors ? Discuss the location of Fermi levels under suitable limiting conditions and give the necessary theory. **6**

4. a) Explain electronic polarization in atoms and obtain an expression for electronic polarizability in terms of the radius of atom. **8**

   b) Explain qualitatively how p-n junction functions as a rectifier. **6**

5. a) Derive the susceptibility expression for ferromagnetic material. **8**

   b) Write a note on ionic polarizability. **6**

6. a) What is effective mass ? Give the expression for the effective mass of an electron. **8**

   b) In an n-type semiconductor, the Fermi level lies 0.3 eV below the conduction band at 300 K. If the temperature is increased to 330 K, find the new position of the Fermi level. **6**

7. a) Explain Type I and Type II superconductors. **6**

   b) Briefly explain the BCS theory of superconductivity and describe one experimental evidence for the existence of energy gap. **8**

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Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Materials Science) (Paper – III)
Analog and Digital Electronics (Old)

Day and Date : Monday, 20-4-2015 Total Marks : 70

Time : 11.00 a.m. to 2.00 p.m.

Instructions *: 1) Q.* ***(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 alternatives : **14**

1) A differentiator has _____ in the input terminal, for an opamp based circuit. **8**

a) Capacitor b) Inductor
c) Resistance d) None of these

2) Multiplexer means _____

a) Many I/P's into one O/P b) One I/P into many O/P's
c) Both a and b d) None of these

3) IC 74150 is _____

a) 16:1 MUX b) 8:1 MUX
c) 1:16 DMUX d) 1:8 DMUX

4) _____ logic gate represents $Y = \overline{A + B}$ operation.

a) OR b) NOR c) AND d) NAND

5) The 4-bit adder circuit can be designed using one half adder and _____ full adder circuits.

a) 3 b) 4 c) 5 d) 7

6) _____ Oscillator circuit uses Inductive feedback.

a) Phase shift b) Wien bridge
c) Hartley d) Colpit

7) An Integrator has _____ in the input terminal, for an Opamp based circuit.
   a) Resistance b) Inductor
   c) Capacitor d) None of these

8) Output impedance of IC 741 is typically _____ Ω .
   a) 100 b) 1000 c) 10 d) 1

b) Fill in the blanks/State **true** or **False :** **6**

i) The number of flip flops required to design MOD 10 counter is _____

ii) In 8085, Opcode fetch cycle is _____ stated.

iii) SR flip flop does not accept the input entry when _____

iv) Colpit oscillator circuit uses tapped inductive feedback.

v) Output impedance of IC 741 is typically 10 Ω .

vi) In 8085, ALE signal is used to demultiplex address/data bus.

2. Attempt following : **14**

1) Addressing modes of 8085 microprocessor. **5**

2) Fixed voltage regulators. **5**

3) Opamp as an Integrator. **4**

3. a) Explain inverting configuration with 3-inputs can be used as a summing scaling or averaging amplifier. **8**

b) IC 741 Opamp configured in inverting mode with R_1 = 1k and R_F = 10K.

Find 1) Exact closed loop gain

2) Ideal closed loop gain. **6**

4. a) Draw and explain phase shift oscillator, obtain an expression for frequency of oscillation. **8**

b) Design a phase shift oscillator for f_0 = 1 KHz, using IC741.
(Supply voltage = $\pm$ 12V). **6**

5. a) Describe architecture of Intel 8085 microprocessor. **8**

   b) Explain demultiplexing of AD7-AD0 signals. **6**

6. a) What is shift register ? Draw and explain logic diagram of PISO shift register. **8**

   b) Draw and explain 8:1 multiplexer using AND gate. **6**

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

   b) Reduce the following logical expressions using Boolean laws :

   $\left(A\overline{B} + AB\right)(\overline{A}BC + ABC)$. **6**

SLR-HP – 380

Seat No.	

M.Sc. (Part – I) (Semester – I) Examination, 2015
PHYSICS (Materials Science) (Paper – IV) (Old)
Analytical Techniques – I

Day and Date: Wednesday, 22-4-2015 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**.*

14

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

1) The range of visible spectra extends over

a) 400 nm to 800 nm b) 200 nm to 800 nm

c) 200 nm to 400 nm d) 150 nm to 200 nm

2) According to Lambert's law, the intensity of the input beam falls to 0.369 times Io for the length of absorption

a) 1 cm b) (1/K) cm c) K cm d) None above

3) The law that relates to the absorption due to solution is

a) Beer's law b) Lambert's law

c) Ferries law d) Both a and b

4) The following transition is a forbiddoned transition

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

5) The ascending order of energy is as below

a) $\sigma, \pi, \pi^*, \sigma^*$ b) $\sigma, \pi^*, \pi, \sigma^*$ c) $\pi, \sigma, \pi^*, \sigma^*$ d) $\pi^*, \sigma, \pi, \sigma^*$

6) Following is not an auxochrome

a) – OH b) – OR c) $-NH_2$ d) C = C

P.T.O.

7) The conjugation causes
   a) Increase in energy of HOMO b) Decrease in energy LOMC
   c) Increase in λ_{max} d) All above
8) Following crystal could be used as optical component is case of the IR spectrometer
   a) NaCl b) Glass c) Quartz d) Plastic

b) Fill in the blanks/State **True** or **False** : **6**
1) Number of NMR signals for $CH_3 - OH$ is _____.
2) The molecular formula for a ketone is _____.
3) The finger print region extends between the λ =
4) In case of nonlinear molecular the vibrational degrees of freedom are $3n - 3 - 2 = 3n - 5$.
5) The chromophores are radicals which cause absorption of visible radiation intensities.
6) The energy of stretching vibrations is greater than the bending vibrations.

2. Write a short note on : **14**
   1) Lambert's law. **5**
   2) Gyroscopic motion of magnetic moment of proton. **5**
   3) Basic principle of FES. **4**

3. a) Describe basic instrumentation setup for UV-VIS spectro photometer. **8**
   b) Explain sources of UV and VIS radiations. **6**

4. a) Draw and explain instrumentation of IR spectrometer. **8**
   b) Give difference between optics for UV-vis and IR spectrometers. **6**

5. a) Describe basic principle of NMR spectroscopy. **8**
   b) Explain mechanism of absorption of magnetic field and transitions in case of NMR spectroscopy. **6**

6. a) Describe instrumentation of mass spectrometer. **8**
   b) Explain basic concept of mass spectroscopy. **6**

7. a) Explain basic principle of AAS. **6**
   b) Describe instrumentation setup for AAS. **8**

_____

SLR-HP – 381

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Materials Science) (New)
Paper – V : Statistical Mechanics

Day and Date : Thursday, 16-4-2015 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 alternatives : **8**

i) The entropy (S) of the system having Ω (E) accessible states is given by

a) k ln Ω (E) b) Nk ln Ω (E)

c) kT ln Ω (E) d) None of these

ii) The mean energy for a classical one dimensional oscillator at temperature T is

a) kT b) $\frac{kT}{2}$ c) $\frac{3kT}{2}$ d) 3kT

iii) The partition function of a single gas molecule is Z_α. The partition function of 'N' such non-interacting gas molecules is then given by

a) $\frac{(Z_\alpha)^N}{N!}$ b) $(Z_\alpha)^N$ c) $N Z_\alpha$ d) $\frac{(Z_\alpha)^N}{N}$

iv) A particle of mass 'm' and total energy 'E' is executing one dimensional simple harmonic motion. Its trajectory in phase space is

a) circle b) ellipse c) parabola d) hyperbola

v) Three physical parameters which remain constant in a system of interest in a micro canonical ensemble are

a) E, V, T b) N, T, μ c) N, V, E d) None of these

P.T.O.

vi) A system consists of three independent particles localized in space. Each particle has two states of energy 0 and ε. When this system is in thermal equilibrium with a heat bath at temperature T, its partition function is given by

a) $(1+e^{-\beta\in})^3$ b) $(1+3e^{-\beta\in})$ c) $(1+e^{-\beta\in})$ d) None of these

vii) Internal energy $(\overline{E})$ of a system is given by

a) $-\frac{\partial}{\partial\beta}\ln Z\big|_{V,N}$ b) $\frac{\partial}{\partial\beta}\ln Z\big|_{V,N}$

c) $-\beta\frac{\partial}{\partial T}\ln Z\big|_{V,N}$ d) None of these

viii) If the volume of the perfect gas of N atoms is doubled then the change in the entropy is

a) zero b) Nk ln 2 c) 2Nk d) none of these

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

i) Canonical ensemble is related to _____ equilibrium of system.

ii) Plank's radiation law can be derived by using _____ statistic.

iii) Fermi energy gives the value of energy in Fermi Dirac system upto which all the energy states are _____

iv) Bose Einstein statistics is not applicable to photons and symmetric particles. (True/False).

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

vi) 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 **any three** of the followings : **14**

a) Show that 1D harmonic oscillator executes elliptical motion.

b) Distinguish between different ensembles.

c) Explain Triple point.

d) Distinguish between 1st order and 2nd order phase transitions.

3. Answer the followings :
   a) Explain Bose-Einstein statistics. **4**
   b) Write the condition for ideal Bose gas. **10**

4. Answer the followings :
   a) Write the condition for Bose-Einstein condensation. **8**
   b) What is the Gibb's paradox ? **6**

5. Answer the followings :
   a) Write the Clausius-Clapeyron's equations using 1^{st} order phase transition. **8**
   b) Write Ehrenfest's equations using 2^{nd} order phase transition. **6**

6. Answer the followings :
   a) Show that average energy of single particle of ideal Fermi gas is 3/5 times the Fermi energy of the system. **10**
   b) Explain Maxwell. Boltzmann statistics. **4**

7. Answer the followings :
   a) Write the Liouville's theorem in classical presentation. **10**
   b) Write the expression for total number of particles (N) following F.D. statistics using grand canonical partition function. **4**

SLR-HP – 382

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Mat.Sci.)
Paper – VI : Quantum Mechanics (New)

Day and Date : Saturday, 18-4-2015 Max. 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** questions from Q. **(3)** to Q. **(7)**.*
*3) **All** questions carry **equal** marks.*
*4) Figures to the **right** indicate marks.*

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

i) According to Schrödinger a particle is equivalent to a **6**

a) single wave b) light wave

c) wave packet d) sound wave

ii) The wave function of a particle in a box of length L is

$$\psi(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{\pi x}{L}\right) \qquad 0 < x < L$$

$\psi(x) = 0$ for $x < 0$ and $x > L$.

The probability of finding it in the region $0 < x < \frac{L}{2}$ is

a) 0. 4% b) 0.3 % c) 0.2 % d) 0.5 %

iii) In case of a wave function $\psi = \frac{e^{ikr}}{r}$, the probability current density is

a) $\frac{v}{r^2}$ b) $\frac{v}{r}$ c) $\frac{v}{r^3}$ d) v

P.T.O.

iv) If proton and electron have same De-Broglie wavelength 2A° then
   a) both have same kinetic energy
   b) both have same velocity
   c) both have same momentum
   d) Kinetic energy of proton is more than K.E. of an electron

v) The degeneracy of hydrogen atom in state n = 3 is
   a) 3 b) 5 c) 6 d) 9

vi) A system is known to be in a state described by the wave function $\psi(\theta,\phi)=\frac{1}{\sqrt{30}}\left[5Y_4^0+Y_6^0+2Y_6^3\right]$ where, Y_l^m are the spherical Harmonics, the probability of finding the system in a state with m = 0 is
   a) 0 b) $\frac{2}{15}$ c) $\frac{1}{4}$ d) $\frac{13}{15}$

B) Write **true** or **false** : **4**

vii) The experimental proof of wave particle duality was given by Thompson.

viii) Hermitian operator has imaginary eigen values.

ix) The graph of a wave function against r for hydrogen for l = 0 state shows one maxima.

x) The experimental ground state energy of the Helium atom is (– 79.00 ev).

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

xi) The M shell can accommodate _____ electrons.

xii) The selection rule for Harmonic oscillator is _____

xiii) The Bohr magneton is _____

xiv) ± 1 eigenvalues belong to an _____ operator.

2. Answer **any 3** in brief : **14**

a) Using proper operators derive ore dimensional Schrödinger equation.

b) If there exists a set of orthogonal functions ψ_i which are eigen functions of the operators A and B then prove that they commute.

c) Write the formula for Normalized wave function of Hydrogen for radial part and explain it.

d) Write a note on Hiesenberg's uncertainty principle.

3. a) Distinguish between Hermitian and unitary operators. **3**

   b) Discuss the problem of one dimensional box of width a comment on the graphs showing energy levels and corresponding eigen functions. **7**

   c) What are the factors which influence the wavelengths of different transitions in an energy spectrum of a box ? **4**

4. a) Discuss the Harmonic oscillator problem. Calculate the energy eigen value and normalized energy eigen functions. **10**

   b) Calculate first few Hermite polynomials upto H_3 and prove $H_3 = 2$ and $H_2 - 4 H_1$. **4**

5. a) Solve the radial wave equation for hydrogen like atom. **10**

   b) Obtain an expression for the probability density of 1s orbital. **4**

6. a) In many electron atoms how the electrons of larger 'l' values reduce the effective charge on the nucleus ? State Slater's rules and hence calculate the effective charge on Nitrogen nuclei. **10**

   b) Explain what is Plater determinant. **4**

7. a) Discuss the Hydrogen molecule ion problem using a proper Hamiltonian Normalized molecular orbitals. Calculate the H_{aa} and H_{ab} type integrals and calculate energies. **10**

   b) What are normalized wave functions ? Evaluate the ground state energy. **4**

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SLR-HP – 383

Seat No.	

M.Sc. – I (Semester – II) Examination, 2015
PHYSICS (Materials Science)
Paper – VII : Electrodynamics (New)

Day and Date : Tuesday, 21-4-2015 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. Objectives. **14**

A) Choose correct alternative : **8**

1) Stationary charges produce only _____ field.
   a) Electrostatic b) Magnetostatic
   c) Both d) None of these

2) Incident and transmitted waves are always _____
   a) In phase b) Out of phase
   c) Out of path d) Depends on value of $\frac{n1}{n2}$

3) When wave gets reflected from the surface of denser medium there is a phase change of _____
   a) 0° b) 90° c) 180° d) 270°

4) Total outward flux of magnetic induction 'B' through any close surface 'S' is equal to _____
   a) One b) Infinite c) Φ d) Zero

5) The total power radiated is _____ of radius of sphere, which is according to law of conservation of_____
   a) Dependent , energy b) Independent, energy
   c) Dependent, momentum d) None of these

P.T.O.

6) Steady current produce_____ fields that are_____ in time.

a) Magnetic, constant
b) Magnetic, variable
c) Electric, constant
d) None of these

7) Potential function $2x^2 + 2y^2 + 2z$ satisfy_____

a) $\nabla^2\phi=0$
b) $\nabla^2\phi \neq 0$
c) $\nabla^2\phi=\rho/\varepsilon_0$
d) All of these

8) The total power radiated by an oscillating dipole is _____to the _____ power of frequency.

a) Proportional, fourth
b) Inversely proportional, fourth
c) Inversely proportional, third
d) proportional, third

B) **True / False :** **6**

1) In case of oblique incidence transmitted wave is always in phase with incident wave.
2) Magnetic vector potential due to magnetic dipole is proportional to r^{-3}.
3) Half wave antenna is a simply straight conductor.
4) Radiation resistance for half wave antenna is 73.2 ohms.
5) The speed which is significant proportion of the speed of light is called relativistic.
6) A plane wave scattered by an electron shows polarization and scattering.

2. Write the short notes **(any three)** : **14**

1) Wave equation in terms of electromagnetic potential.
2) Skin depth.
3) Terminology of sin wave
4) Polarization of EM wave.

3. a) Give the interaction between two current loops. **8**

   b) Give the expression for energy stored in electric and magnetic fields. **6**

4. a) Explain reflection and refraction of electromagnetic wave across the interface for the case of oblique incidence. **8**

   b) Give electromagnetic wave equation for the wave travelling through free space. **6**

5. a) Write the equations of linear quadrupole potential and field. **8**

   b) Write integral forms of Maxwell's equations. **6**

6. a) Write in detail Lienard-Wiechert potential. **8**

   b) Explain radiation damping. **6**

7. a) Explain radiation form an oscillating electric dipole. **8**

   b) Explain radiation form half wave antenna. **6**

SLR-HP – 384

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Materials Science) (New)
Analytical Techniques (Paper – VIII)

Day and Date : Thursday, 23-4-2015 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.*
4) ***Use*** *of log table or nonprogrammable calculator is* ***allowed****.*

1. Objective questions : **14**

a) Select correct alternative : **8**

1) The mass absorbance coefficient of X-rays depend upon _____
   a) Atomic weight b) Atomic number
   c) Volume electron d) Number of neutron

2) Bremsstrahlung consist _____ wavelength of radiation.
   a) single b) two
   c) triple d) multiple

3) 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 pathlength

4) XPS working is based on principle of
   a) Photoelectric effect b) Photovoltaic effect
   c) Lamberts law d) 200-800 nm

P.T.O.

5) Infrared spectroscopy provides valuable information about

a) Molecular weight b) Melting point

c) Functional group d) Conjugation

6) Which of the following spectroscopic process requires the conservation of energy ?

a) Absorption b) Emission

c) Scattering d) All of the above

7) Which of the following properties must change for a mode to be Raman active ?

a) Volume b) Dipole moment

c) Polarisability d) All of the above

8) A compound showing IR absorption in the range 2100-2260 cm^{-1} is due to the presence of

a) $C \equiv N$ b) $C \equiv C$ c) $C = C$ d) $C = O$

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

1) An X-ray spectrum gives the relative number of X-rays emitted at each photon.

2) Ultra high vacuum is used in XPS to increase the mean free path for electrons, ions and photons.

3) The Raman shift depends on the energy spacing of the molecule's mode.

4) Minimum energy required to ionize hydrogen atom from its ground state is 11.6 eV.

5) IR spectroscopy is helpful for identification of organic compound.

6) Deuterium lamp is a source of visible radiation.

2. Write short notes : **14**

1) Various modes of vibrations in a molecule. **5**

2) Depth profiling in XPS. **5**

3) Structure factor in crystallography. **4**

3. a) How are the lattice parameters of tetragonal and hexagonal structures are determined ? Explain with an appropriate diagram and derivations. **8**

   b) Describes the instrumentation and working of FTIR spectrometer. **6**

4. a) Why Fourier Transform IR spectroscopy more useful than dispersive IR spectroscopy ? **10**

   b) What is chemical shift ? **4**

5. a) Explain the working and principle of a double beam UV-VIS spectrophotometer with block diagram ? **8**

   b) State Bragg's law and explain the working of X-ray diffractometer. **6**

6. a) What is Attenuated Total Reflection technique ? How it can be used analyze the specimen ? **8**

   b) What is the importance of Raman spectroscopy ? What the stokes and anti-stokes line indicate in the Raman spectra ? **6**

7. a) Write a note on selection rules in simple harmonic oscillator in parallel and perpendicular vibration. Explain skeletal vibration and why it is different from characteristic group vibration. **8**

   b) What are different types of bonds present in materials ? Discuss with an appropriate example. **6**

SLR-HP – 385

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Materials Science)
Paper – V : Statistical Mechanics (Old)

Day and Date : Thursday, 16-4-2015 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) Figure to **right** indicates **full** marks.*

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

1) Boltzmann's limit of Bosons and Fermions is

a) $e^{\beta\mu} << 1$ b) $e^{\beta\mu} >> 1$ c) $e^{+\beta\mu} >> 1$ d) $e^{-\beta\mu} >> 1$

2) The total energy of the particle which is a constant of motion is given by

a) $E = P^2/m$ b) $E = P/2m$
c) $E = P^2/2 + 1/2\ Kq^2$ d) $P^2/2m + 1/2\ Kq^2$

3) 'μ' space for single particle is

a) Two dimensional b) Three dimensional
c) Six dimensional d) Dimension less

4) Louville's equation gives the rate of change in

a) Pressure b) Temperature c) Density d) Volume

5) Temperature at critical point is

a) 3b b) 8/27R c) 3b/27Rb d) 8a/27Rb

6) 'α' is related with chemical potential (μ) by the relation

a) kT/μ b) $-\mu/kT$ c) μ/β d) $\mu T/k$

7) Gibbs potential is given by the relation

a) $G = E - PV + TS$ b) $G = E + PV + TS$
c) $G = E - PV - TS$ d) $G = E + PV - TS$

8) At a critical point dp/dv =

a) 1 b) 0 c) ∞ d) –1

P.T.O.

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

1) Clasius-Clapeyron equation gives rate of change of pressure along equilibrium curve.
2) Diffusion process is irreversible.
3) The point at which the vapour pressure curve abruptly terminates is called transition point.
4) The equation of reduced state requires the values of constants a and b.
5) Gibbs paradox is related to entropy change.
6) In micro canonical ensemble both energy and mass is conserved.

2. Attempt following : **14**
   a) Energy fluxuations in canonical ensemble
   b) Microstates and macrostates
   c) Law of corresponding states.

3. a) What is Gibbs paradox ? How it is resolved ? **10**
   b) Explain phase transition using PT diagram. **4**

4. a) Give the condition for ideal Bose gas. **10**
   b) Explain grand canonical ensemble. **4**

5. a) By using Vander walls equation of reduced state, calculate the values of critical constants. **10**
   b) What is phase space and quantum state ? **4**

6. a) What is Brownian motion ? Write Langivin's theory of Brownian motion. **8**
   b) Explain fluctuation dissipation theorem. **6**

7. a) Show that average energy of single particle of ideal fermi gas is 3/5 times the Fermi energy of the system. **10**
   b) Write about MB statistics. **4**

SLR-HP – 386

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Old)
Material Science
Paper No. – VI : Quantum Mechanics

Day and Date : Saturday, 18-4-2015 Total Marks : 70
Time : 11.00 a.m. to 2.00 p.m.

***Instructions** : 1) Q.No. **1** and Q. No. **2** are **compulsory**.*
*2) Attempt **any three** questions from Q. No. **3** to Q. No. **7**.*
*3) **All** questions carry **equal** marks.*

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

1) For a given $\psi(x)$, $\int \psi^* \psi . d^3x = 0$ says that probability of finding the object anywhere is
   a) zero b) constant
   c) the wavefunction is absent d) the wavefunction vanishes

2) Dirac delta is used with
   a) discrete observables b) antisymmetrized observables
   c) continuous observables d) bra and ket notations

3) The points inside the box where the wavefunction is zero are called
   a) Quantum numbers b) Nodes
   c) energy levels d) Solutions

4) The exact solution of many-body can be obtained in
   a) Classical mechanics b) Quantum mechanics
   c) Cosmology d) None of the above, nor elsewhere

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

6) The no. of electrons circulating about the positively charged nucleus in a hydrogen like atom is

   a) Equal to the number of protons in 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 gaps. **3**

1) An observable can be represented by _____.

2) Any operator that commutes with the _____ operator is called a constant of motion.

3) Separation of electronic and nuclear function describes the _____ principle.

C) State **True** or **False** : **3**

1) ψ and its derivative with respect to its variables are continuous.

2) For a free particle the momentum operator is a constant of motion.

3) The wave function of a system must be symmetric with respect to interchange of every pair of electrons.

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

a) Write a short note on QM wave function ψ and its interpretation.

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

c) Write a note on many electron atoms.

d) Write a note on Born-Oppenheimer approximation and justify it using experimental data for the Hydrogen molecule.

3. a) What is the general procedure for setting up a quantum mechanical operator ? Illustrate it by setting up operators for **10**

i) Components of linear momentum

ii) The Hamiltonian and

iii) Components of angular momentum.

b) Find the energy jump in electron volts for the emission of visible light of wave-length 7500 Å. **4**

4. 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) Show that the product of two Hermitian operators is Hermitian if they commute. **4**

5. a) Define and solve the energy eigenvalue problem for a harmonic oscillator. What is zero point energy ? **10**

   b) For the ground state of the one-dimensional harmonic oscillator show that the average value of its kinetic and potential energies are equal. **4**

6. a) Formulate the Schrodinger equation for many electron atoms. Why these equations cannot be solved ? What is the method suggested by Hartree ? **10**

   b) Show that electron density in a filled shell of orbitals, like the configuration p^6 and d^{10}, is spherically symmetrical. **4**

7. a) Stating the basic assumptions involved, develop the molecular orbital theory for an n-atom molecule. **10**

   b) Show that L+ and L– are not but L – L+ and L + L – are Hermitian. **4**

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SLR-HP – 387

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (MATERIALS SCIENCE) (Old)
Paper – VII : Physical Chemistry

Day and Date : Tuesday, 21-4-2015 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 **right** indicates **full** marks.*

1. Select correct alternative : **14**

1) Enthalpy of an exothermic reaction is _____

a) always zero b) always negative

c) always positive d) may be positive or negative

2) Which of the following expression is correct for the first order reaction (A_0 refers to initial concentration).

a) $t_{1/2} \alpha A^1$ b) $t_{1/2} \alpha A^{-1}$ c) $t_{1/2} \alpha A_0$ d) $t_{1/2} \alpha A^2$

3) Hess's law is applicable to _____

a) rate of reaction

b) equilibrium constant

c) changes in heat of reaction

d) the influence of pressure on reaction rate

4) Which of the following reaction is correct where, terms have their usual meaning ?

a) $\Delta s = \frac{1}{T}(\Delta H - \Delta G)$ b) $\Delta H = \Delta G - T\Delta S$

c) $\Delta S = \frac{1}{T}(\Delta G - H)$ d) $\Delta H = \Delta G + T\Delta S$

P.T.O.

5) The concentration of the reactants is reduced to 25% for a first order reaction in one hour. The half life period of the reaction is _____

a) $\frac{1}{2}$ hr b) $\frac{1}{4}$ hr c) $\frac{3}{4}$ hr d) 4 hr

6) Which of the following reaction is correct ?

a) $\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$ b) $\left(\frac{\partial V}{\partial T}\right)_P = \left(\frac{\partial S}{\partial V}\right)_T$

c) $\left(\frac{\partial G}{\partial T}\right)_P = S$ d) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

7) Which of the following will form a cell with the highest voltage ?

a) 1M A_g^+, 1M CO^{2+} b) 2M A_g^+, 2M CO^{2+}

c) 0.1M A_g^+, 2M CO^{+2} d) 2M A_g^+, 0.1M CO^{+2}

8) The e.m.f. of a galvanic cell composed of two hydrogen electrodes is 272 mV. What is the pH of the solution in which the anode is immersed if the cathode is in contact with a solution of pH = 3.

a) 3 b) 6.7

c) 7.6 d) 10

9) The electrode potential of hydrogen electrode in neutral solution at 298 K is _____

a) – 0.41 V b) zero V

c) – 0.49 V d) 0.41 V

10) What is CMC of solution ?

a) calculated Molar concentration

b) critical Micelle concentration

c) coulombic mass charge

d) curies magnetic constant

11) Which of the following has no effect on the rate of a reaction ?

a) enthalpy change b) temperature

c) catalyst d) concentration of reactants

12) The Arrhenius equation of effect of temperature on the rate constant of a reaction is _____

a) $K = A.e^{-\varepsilon a/RT}$ b) $K = \log\left(\varepsilon a/RT\right)$

c) $K = e^{-\varepsilon a/R^2T}$ d) $K = \varepsilon a/RT$

13) According to the third law of thermodynamics at 0°K the entropy is zero for _____

a) Covalent solids at 25 atm pressure
b) Elements in their stable form
c) Perfectly crystalline solids
d) Any compound in their liquid form

14) Which of the following is anionic surfactant ?

a) CTAB
b) Sodium dodecyl sulphate
c) Benzyl thionium chloride
d) Cetrimonium chloride

2. Attempt the following : **14**

a) What is partial molar entropy and how it can be determined by calorimetry ? **5**

b) Derive the relationship between the relaxation time τ and K_1 and K_2 for fast reaction

$$A + B \underset{K_1}{\overset{K_2}{\rightleftharpoons}} C$$ **5**

c) What is EMF ? Give applications of EMF. **4**

3. a) Explain the terms activity coefficient and mean ionic activity coefficient. Discuss in detail the Debye-Huckel theory of mean ionic activity coefficient. **10**

b) Explain electrodeposition technique for any of electrochemically active compound of your choice. **4**

4. a) Define the terms Gibbs free energy and Helmholtz free energy. How is each of these terms related to maximum work that can be done by a system during a given change ? Discuss the variation of ΔG with variation in
   i) Temperature and pressure.
   ii) Pressure and volume. **10**

   b) Explain the terms fugacity and activity. How are they related to chemical potential ? What is the physical significance of fugacity ? **4**

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

   b) Discuss dynamics of parallel and complex reactions. **4**

6. a) Discuss the collision state theory for bimolecular reaction rates. Compare between transition and collision state theories. **10**

   b) What is decomposition potential ? How it can be determined experimentally ? **4**

7. a) What are concentration cells ? Derive expressions for the emfs of concentration cells **10**
   i) With transference
   ii) Without transference.

   b) Derive, $C_P - C_V = R$. Define the terms involved in the equation. **4**

SLR-HP – 388

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
PHYSICS (Materials Science) (Old)
Paper – VIII : Analytical Techniques – II

Day and Date : Thursday, 23-4-2015 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. No. **3** to Q. No. **7**.*

*3) **All** questions carry **equal** marks.*

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

1) Which of the following statement is most correct about Atomic Force Microscopy (AFM) ?

a) AFM can visualize protein bound to DNA molecules

b) AFM can visualize unfixed specimens in water or buffer

c) AFM moves a very sharp tip over the surface of the specimen to "feel" its shape

d) All the statements above are true

2) A photon with energy of one electron volt (1 eV = 1.602×10^{-12} ergs) has a wavelength of

a) 1.24×10^{-2} cm b) 3720 $\mathring{A}$

c) 3.0×10^{-5} cm d) 1,240 $\mathring{A}$

3) The energy of photon absorbed by an atom will be equal to

a) Ionization energy + Kinetic energy

b) Ionization energy

c) Kinetic energy

d) Ionization energy – Kinetic energy

4) Which type of scattering results in stronger wavelength than the incident light ?

a) Rayleigh b) Stokes c) Anti-stoke d) None of the above

P.T.O.

5) A microscope in which an image in formed by passing an electron beam through a specimen and focusing the scatters electron with magnetic lenses is called a
   a) Scanning tunneling microscope
   b) Scanning electron microscope
   c) Atomic force microscopy
   d) Transmission tunneling microscope

6) 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

7) The structure factor is particularly useful tool in the interpretation of interference pattern in
   a) X-Rays
   b) Electrons and neutrons
   c) Diffraction experiment
   d) All of the above

8) The wavelength of continuous X-rays depends upon
   a) Target materials
   b) Filament current
   c) Accelerating potential difference
   d) All of the above

B) Fill in gaps : **6**

i) Atomic force microscopy can be operated _____ different modes.

ii) The coordination number of hcp structure is _____

iii) _____ are used to produce photoelectrons in XPS.

iv) The ultraviolet photoelectron spectroscopy was developed to study the photoelectron spectra of free molecules in the _____ phases.

v) The finger print region in the IR spectrum is _____ to _____ cm^{-1}.

vi) Elastic scattering of photon is known as _____ scattering.

2. Write a notes on : **6**
   1) Advantages of AFM over the conventional microscopy techniques. **5**
   2) Explain the interaction electron with matter. **5**
   3) Explain the terms :
      i) Acquisition of raw data and
      ii) Data processing in X-ray diffraction techniques. **4**

3. a) Draw schematic diagram of the scanning electron microscopy and explain the experimental details along with image formation and detectors used. **8**
   b) Explain the working principles of IR spectroscopy. **6**

4. a) Describe the instrumentation and working of X-ray diffractometer. **8**
   b) Explain valence band analysis and work function measurement in UPS. **6**

5. a) Explain the theory of Infrared absorption in IR spectroscopy. With the help of a typical FTIR spectrometer layout explain how the constructive and destructive interference pattern generated. **8**
   b) Write a note on ultraviolet photoeletron spectroscopy. **6**

6. a) Explain the principle and working of Raman spectroscopy. **8**
   b) What is the Bragg diffraction condition, assume the X-rays fall on the crystal planes at some grazing angle θ ? How the crystalline size is estimated from the incidence of X-ray's on the crystals ? **6**

7. a) Explain the working and principle of X-rays photoelectron spectroscopy with appropriate block diagram. **8**
   b) Explain the difference between WDS and EDS. **6**

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Seat No.	

M.Sc. – II (Semester – III) Examination, 2015
PHYSICS (Materials Science)
Paper – IX : Semiconductor Devices

Day and Date : Wednesday, 15-4-2015 Max. Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions *: 1) Attempt **5** questions.*
*2) Questions **1** and **2** are **compulsory**.*
*3) Attempt **any 3** from questions **3** to **7.***
*4) **Use** of non programmable calculator is **allowed**.*

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

1) The safety factor for a power diode is given by _____

a) $\frac{t_a}{t_b}$ b) t_b / t_a

c) $\frac{1}{t_a \cdot t_b}$ d) $t_a \cdot t_b$

2) A transistor is said to have a forced β (β_F) when β is _____

a) $\frac{I_C(sat)}{I_B}$ b) $\frac{I_B}{I_C(sat)}$

c) $I_B \cdot I_C(sat)$ d) $\frac{1}{I_B \cdot I_C(sat)}$

3) Which of the following is better than CMOS inverter ?

a) DTL b) RTL
c) TTL d) ECL

4) MOS controlled thyristor is a combination of _____

a) Thyristor and a transistor b) Thyristor and a diode
c) Thyristor and a thyristor d) Thyristor and a MOSFET

P.T.O.

5) A triac is a combined effect of two SCR's connected in _____
   a) Series
   b) Parallel
   c) Antiparallel
   d) Both a) and b)

6) For an ideal MIS diode E_F remains constant in the semiconductor because _____
   a) $dI/dx = 0$
   b) $dI/dx \neq 0$
   c) Both a) and b)
   d) None

7) The ground state degeneracy of an accepter is _____
   a) 1
   b) 2
   c) 3
   d) 4

8) In an ideal MOS diode, the surface potential (ψ_s) deep inside the semiconductor is _____
   a) $\psi_s = \psi_{max}$
   b) $\psi_s = \psi_{min}$
   c) $\psi_s = \frac{\psi_{max}}{z}$
   d) $\psi_s = 0$

9) An intrinsic Debye length for holes is _____
   a) $\sqrt{\frac{KT \in_s}{p_{p_o}}}$
   b) $\sqrt{\frac{K.T. \in_s}{n_{p_o} \cdot q^2}}$
   c) $\sqrt{\frac{K. \in_s}{p_{p_o} \cdot q}}$
   d) $\sqrt{\frac{K. \in_s}{n_p \cdot q}}$

10) Flat band shift is due to _____ charges.
   a) Mobile ionic
   b) Fixed oxide
   c) Oxide trapped
   d) Interface trapped

11) Light emission is not possible in Si because of its _____
   a) direct band gap
   b) high mobility
   c) indirect band gap
   d) carrier concentration

12) D-MOSFET means _____ MOSFET.
   a) Double dimensional
   b) Depleted
   c) Double diffused
   d) Dimensionless

13) Resonant tunneling diode has a cut-off frequency in the _____ range.

a) KHz b) MHz

c) GHz d) THz

14) The dominating operating process in PV-detector/Solar cell is _____

a) Stimulated emission b) Absorption

c) Reflection d) Transmission

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

1) Explain reverse recovery characteristic of a power diode. **5**

2) Write a note on triac. **4**

3) What is a CMOS ? **5**

4) Conductance measurement technique for measurement of surface traps. **4**

3. a) What is a MCT ? With a block constructional details explain the turn ON and turn OFF process in MCT's ? **10**

b) State the important applications of MCT. **4**

4. a) Explain the variation of total capacitance of an ideal MOS-system with applied voltage. **10**

b) What is flat bad condition ? State the magnitude of flat band capacitance. Interpret it. **4**

5. a) Give a brief account of two transistor analogy of a thyristor. **8**

b) Write a note on interface trapped charges. **6**

6. a) What is CCD ? With a good sketch of an energy band diagram, explain what do you mean by accumulation, depletion and inversion of the charges for the p and n-type semiconductors. **10**

b) Compare the salient features of the above processes. **4**

7. Attempt the following : **14**

a) Modern MOSFET's are fabricated on a $\langle 100 \rangle$ oriented silicon – Comment. **6**

b) Protection of a thyristor against dv/dt. **4**

c) Transferred electron effect in GaAS. **4**

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SLR-HP – 390

Seat No.	

M.Sc. – II (Semester – III) Examination, 2015
PHYSICS (Materials science) Paper – X
Instrumentation

Day and Date : Friday, 17-4-2015 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**

i) In LVDT, which of the following varies with the input displacement.

a) resistance b) capacitance

c) inductance d) temperature

ii) A pH meter is used measure

a) acidity of a solution

b) alkalinity of a solution

c) neutrality of a solution

d) all of the above

iii) In signal conditioning systems, an external excitation is required for

a) Thermo couples b) Piezo-electric crystals

c) Strain gauges d) Inductive pick-ups

iv) In an op-amp logarithmic amplifier, the output voltage forms a logarithmic function of the

a) input voltage b) output voltage

c) reference voltage d) peak voltage

P.T.O.

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

a) Mixer b) Comparator

c) Amplifier d) Rectifier

vi) Operations such as multiplication, division, power etc. can be done using

a) lock-in amplifier b) DC amplifier

c) logarithmic amplifier d) AC amplifier

vii) Which of the following is a – ve temperature coefficient device

a) Thermocouple b) Thermistor

c) Strain gauge d) Loud Speaker

viii) Supply of high voltage signals can be prevented by using

a) Instrumentation amplifier

b) Active filters

c) Operational amplifier

d) Isolation amplifier

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

i) The output of the thermocouple is in the form of _____

ii) Photo emissive cell is an _____ transducer.

iii) Hydrogen ion concentration of a solution can be measured with _____ meter.

iv) UPS requires _____ for its operation.

v) Revolutions per minute can be measured using _____ meter.

vi) In SMPS, transistors are mainly used as _____ devices.

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

a) Discuss the applications of temperature sensors.

b) Write the feedback fundamentals.

c) Explain the operation of RMS converter.

d) Write a note on dynamic signal filtering.

3. a) Discuss the construction and operation of different types of temperature transducers. **10**

   b) Write the advantages and disadvantages of each of them. **4**

4. a) Describe with neat diagram, the working of an isolation amplifier and explain with illustration how it is used to protect the system. **10**

   b) Write the applications of instrumentation amplifier. **4**

5. a) Describe the construction and working of a digital storage oscilloscope. **10**

   b) Write a note on power meter. **4**

6. a) With neat block diagram, explain the constructional features of a spectrum analyzer. **10**

   b) Discuss the static signal conditions. **4**

7. a) Explain the various functional blocks of a multichannel data acquisition system. **10**

   b) Write the applications of logic state analyzer. **4**

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Seat No.	

M.Sc. II (Semester – III) Examination, 2015
PHYSICS (Materials Science)
Paper – XI : Elements of Materials Science

Day and Date : Monday, 20-4-2015 Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions : *1) Q. (**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) Choose the correct alternative : **8**

1) Strength of van der Waals bonds is _____ that of ionic bonds.
   a) less than b) greater than
   c) equal to d) none of the above

2) Amorphous materials have _____ range order and _____ range disorder.
   a) long, long b) short, short
   c) short, long d) long, short

3) Type of bonding in Al is
   a) covalent b) metallic
   c) hydrogen d) van der Walls

4) The solids that can absorb visible light are
   a) semiconductors b) metals
   c) insulators d) ceramics

5) Electrical conductivity of metals _____ with temperature.
   a) increases b) decreases
   c) do not change d) none of the above

P.T.O.

6) The process occurring in LED is
   a) phosphorescence b) radiation
   c) electroluminescence d) fluorescence

7) Photodiodes are normally biased in _____ mode.
   a) forward b) reverse
   c) both forward and reverse d) none of the above

8) One dimensional nanostructures are
   a) Quantum dots b) Quantum wells
   c) Quantum wire d) None of the above

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

1) Relation between resistance and resistivity is _____

2) Relation between electrical conductivity and carrier mobilities is _____

3) For intrinsic semiconductors the position of Fermi-energy level is _____

4) Silicon carbide is _____ type of material.

5) At absolute zero, intrinsic semiconductor behaves like a _____

6) Thermal conductivity of metals is very _____

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

1) How ceramics differ from polymers ?

2) Explain the mechanism of polymerization.

3) Discuss one method to manufacture polymers.

3. a) Discuss the classification of engineering materials. **6**

   b) Discuss with example ionic bond and hydrogen bonds. **8**

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

   b) Discuss the effect of doping on carrier concentration and mobilities. **8**

5. a) Discuss the change in light intensity as light travels through a absorbing material. **6**

   b) What are different types of luminescence ? **8**

6. a) Explain the mechanism of photoconductivity in semiconductors. **8**

   b) Write short note on cathodoluminescence. **6**

7. a) Explain the physics behind functioning of photodetectors. **8**

   b) Explain any one method that can be used for synthesis of nano structured materials. **6**

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SLR-HP – 392

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2015
PHYSICS (Materials Science)
Paper – XII : Dielectric and Ferroelectric Materials

Day and Date : Wednesday, 22-4-2015 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 the correct alternative : **6**

1) An electromagnetic wave going through vacuum is describe by $E = E_0 \sin(kx - \omega t)$ and $B = B_0 \sin)(kx - \omega t)$ then

a) $E_0 k = B_0 \omega$ b) $E_0 B_0 = \omega k$

c) $E_0 \omega = B_0 K$ d) None of these

2) The differential form of Gauss's law in CGS system is _____

a) $\nabla.\overline{E} = \rho / \in_0$ b) $\in_0 \text{div}\,\overline{E}$:

c) $\nabla.\overline{E} = 4\pi\rho$ d) $\text{div}\,\overline{E} = 4\pi\sigma$

3) Polarization in a dielectric on application of electric field is _____

a) Displacement/separation of opposite charge centres

b) Passing of current through dielectric

c) Breaking of insulation

d) Excitation of electrons to higher energy levels

4) Above curie temperature, the spontaneous polarization for ferroelectric material is

a) zero b) 1 c) $\frac{1}{2}$ d) infinity

P.T.O.

5) Luminescence is because of
   a) Photons emitted while excited electrons drops down
   b) Knocking out of electrons by photons
   c) Phototons stimulated by photons
   d) All of above
6) Pyrometer works on _____
   a) Laser Technology
   b) Photo-conduction
   c) Thermal emission
   d) Tyndall effect

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

1) For electromagnetic waves in free space, the field vectors $\overline{E}$ and $\overline{H}$ are in the same phase.
2) Gold and silver are dielectric materials.
3) Ferroelectric materials is not characterized by a sharp dependence of polarization on temperature.
4) Gauss law is used to calculate the electric field due to a symmetric distribution of charges.
5) Optical property of a material is defined as its interaction with electro-magnetic radiation in the visible range.
6) Solar cell works based on photo-conduction.
7) Fluorescence occurs within 10^{-5} ms.
8) The piezo-electric property of a crystal is the principle of quartz clock.

2. Write short answers : **14**
   1) State and prove Gauss law. **5**
   2) Establish Clausius-Mosotti equation. **5**
   3) Explain in brief photovoltaic effect. **4**

3. a) Discuss in detail electric polarization of dielectric material and its relaxation in static electric field. **10**
   b) Give the difference between luminescence and fluorescence. **4**

4. a) Sketch the equilibrium phase diagram of the $Pb(Zr, Ti)O_3$ system and explain microstructure of the unit cell for different phases. **10**

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

5. a) Discuss in detail phenomenological properties and mechanism for $BaTiO_3$ crystal. **10**

   b) Enlist the any four applications of piezoelectrics. **4**

6. a) Discuss the space charge polarization and hopping polarization in case of any class of ferroelectrics. **10**

   b) State the Kramers-Kroning equation. **4**

7. a) Prove that the following Maxwell's equations $\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$ and

   $\nabla \times \bar{H} = \bar{J} + \frac{\partial \bar{D}}{\partial t}$. **10**

   b) Define : **4**

      i) Unit of Debye.

      ii) Chemical unit of mole.

SLR-HP – 393

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2015
PHYSICS (Material Science)
Paper – XIII : Computational Methods and Programming

Day and Date : Thursday, 16-4-2015 Max. Marks : 70
Time : 3.00 p.m. to 6.00 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) The order of convergence in Newton Raphson method is

A) 2 B) 3

C) 0 D) 1

ii) If $y = ae^{cx}$, then the first normal equation is $\sum \log y =$

A) $an + \log c \sum x$

B) $a \sum x + c \sum x^2$

C) $n \log a + c \sum x$

D) $a \sum x + c \sum x^3$

iii) The Newtons forward difference formula is most suitable for the case where independent variable is present at

A) lower part

B) upper part

C) central part

D) any where in the difference table

P.T.O.

iv) Gauss for n = 2 for the $\int_{-1}^{1} f(x)\,dx$ is

A) $f\left(-\sqrt{\frac{5}{3}}\right)+f\left(\sqrt{\frac{5}{3}}\right)$

B) $f\left(-\sqrt{\frac{3}{5}}\right)+f\left(\sqrt{\frac{3}{5}}\right)$

C) $f\left(-\sqrt{\frac{2}{3}}\right)+f\left(\sqrt{\frac{2}{3}}\right)$

D) $f\left(-\sqrt{\frac{1}{3}}\right)+f\left(\sqrt{\frac{1}{3}}\right)$

v) Using Runge Kutta method of order four, the value of y(0.1) for $y' = x - 2y$, y(0) = 1, taking h = 0.1, is _____

A) 0.813 B) 0.825 C) 0.0825 D) 0.0813

vi) Adams Bashforth method is used for

A) Solving integral equations

B) Solving differential equation

C) Evaluating integrals

D) Differentiation

b) State **true** or **false** or fill in the blanks. **8**

i) To fit the equation $y = a + bx + cx^2$ by least square principal, the number of normal equations will be 3.

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

iii) Using intermediate value theorem, the root of the equation f(x) = 0 lies between [a, b] provided f(a) . f(b) < 0.

iv) The interval in which the a real root of equation $x^3 - 2x - 5 = 0$ lies is _____

v) Gauss-Jordan matrix inversion method is valid for only if the coefficient matrix "A" is singular.

vi) To fit a straight line $y = a + bx$ the second normal equation using the method of least square will be $\sum xy = a\sum x + b\sum x^2$.

vii) In Predictor-corrector methods four initial values may be found with the help of Runge-Kutta method.

viii) The Newton Raphson method fails when _____ is zero.

2. Write short notes on :

a) Write a note on Randam Walks. **5**

b) Write note on normal equations for the curve $y = ax^b$. **4**

c) Explain Bisection method and derive its n^{th} iteration formula. **5**

3. a) The following data are taken from the steam table : **6**

Temperature T in °C	140	150	160	170	180
Pressure kgf/cm^2	3.685	4.854	6.302	8.076	10.225

Find the pressure at temperature t = 175°C.

b) Explain the principal of least square for the fitting a curve from given data. Fit a curve $y = ax^2 + bx + c$ to the following data. **8**

x :	1	2	3	4	5
y :	5	12	26	60	97

4. a) Solve for a positive root of $xe^x - 3 = 0$ by regula False method, correct to three decimal places. Also solve $x^3 - 2x - 1 = 0$ by bisection method. **10**

b) Solve the following system of equations by Gauss elimination method **4**

$x + 2y + z = 3$

$2x + 3y + 3z = 10$

$3x - y + 2z = 13$

5. a) Given $\frac{dy}{dx} = xy + y^2$ with $y(0) = 1$ find y at $x = 0.1, 0.2, 0.3$ by Runge Kutta method of fourth order. Also find the y at $x = 0.4$ using Milne's method. **8**

   b) Solve the following system of equation by Gauss Seidal method
   $8x - y + z = 18.$ **6**
   $2x + 5y - 2z = 3$
   $x + y - 3z = -16$

6. a) Use Gauss Jordan matrix inversion method to solve **8**
   $x + y + z = 8$
   $x - y + 2z = 6$
   $3x + 5y - 7z = 14$

   b) Solve $\frac{dy}{dx} = x^2y - 1$ with $y(0) = 1$ find y at $x = 0.1$ and at $x = 0.2$ by Taylor's series method. **6**

7. a) Evaluate $\int_0^1 \frac{1}{1+x}\,dx$ by two and three point Gaussian quadrature formula. **6**

   b) Evaluate $\int_{0.2}^{1.4} \left(\sin x - \log x + e^x\right) dx$ using Simpson's one third and Simpsons three eighth rule. **8**

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Seat No.	

M.Sc. II (Semester – IV) Examination, 2015
PHYSICS (Material Science) (Paper – XIV)
Microelectronics

Day and Date : Saturday, 18-4-2015 Total Marks : 70

Time : 3.00 p.m. to 6.00 p.m.

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

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

i) The interstitial voids in silicon for receiving an impurity atom are
a) 8 b) 4 c) 5 d) 7

ii) The impurity profile in an interstitial diffusion is
a) logarithmic b) erf.C c) linear d) gaussian

iii) For microelectronic applications, growth of single crystal silicon must be along _____ direction.
a) (111) b) (101) c) (011) d) (110)

iv) An aspect ratio is
a) L/W b) R/L c) W/L d) L/R

v) A _____ photoresist is popularly used for IC-fabrication.
a) Isofine Kodak – 820 b) Novolac
c) KPR d) Isopoly-K – 747 MR

vi) The purple plague is
a) $AuAl_2$ b) $AuAl_3$ c) Al_2O_3 d) AuAl

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

P.T.O.

viii) The base width of a normal npn transistor is of the order of _____ μm .

a) 1 t0 2 μm b) 6 to 8 μm

c) 0.6 to 0.8 μm d) 0.06 to 1 μm

ix) In constant source diffusion, diffusion source consists of _____ amount of impurity.

a) a finite b) zero

c) an infinite d) finite as well as infinite

x) 1 mil = _____ inch.

a) 10^{-3} b) 10^{+3} c) 10^{4} d) 10^{-4}

xi) A dielectric isolation _____ the parasitic capacitance.

a) reduces b) does not affect

c) increases d) none of the above

xii) An important advantage of ion implantation is that the process is a _____ temperature process.

a) low b) high c) intermediate d) excessively high

xiii) Minimum aspect ratio is

a) 1 : 1 b) 1 : 5 c) 1 : 10 d) 1 : 3

xiv) In metallization, contacts are usually made with

a) Au b) Mg c) P d) AS

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

a) Photographic mask

b) Czechrlaski technique

c) Boron gettering

d) Discuss : epitaxy Vs. diffusion.

3. a) Evaluate an epitaxial layer through :

i) Measurement of sheet resistance.

ii) Impurity profile. **10**

b) Write a note on substitutional diffusion. **4**

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

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

5. a) Explain how an npn transistor is integrated using planar process. **10**

   b) Write a note on positive photoresist. **4**

6. a) Give a brief account of ion implantation process. **10**

   b) What is complete oxide isolation ? **4**

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

   a) Phosphorus diffusion system.

   b) Etch back effect.

   c) Wedge bonding.

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Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2015
PHYSICS (Materials Science)
Paper – XI : Magnetic Materials

Day and Date : Tuesday, 21-4-2015 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 coercivity of the material is a micro-structure sensitive property. This dependence is known as

a) Magnetic moment b) Magnetic shape anisotropy
c) Magnetization d) Susceptibility

2) Example for dia-magnetic materials

a) super conductors b) alkali metals
c) transition metals d) ferrites

3) Example for anti-ferro-magnetic materials

a) salts of transition elements b) rare earth elements
c) transition metals d) ferrites

4) The magnetic domains in a non-magnetized piece of iron are characterized by which orientation ?

a) parallel to the magnetic axis
b) anti-parallel (opposite direction) to the magnetic axis
c) random
d) perpendicular to the magnetic axis

5) The inverse magnetostrictive effect is also known as

a) Curie effect b) Neel effect

c) Weiss effect d) Villari effect

6) A narrow transition region at the boundary between magnetic domains is called

a) Bloch wall b) Neel wall c) Curie wall d) Weiss wall

7) The property of ferromagnetic materials that causes them to change their shape or dimensions during the process of magnetization is called

a) Magnetoresistance b) Electrostriction

c) Magnetostriction d) None of these

8) The primary source of magnetocrystalline anisotropy is

a) Spin motion b) Orbital motion

c) Spin-orbit interaction d) None of these

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

1) The magnetic domains in a non-magnetized piece of iron are characterized by perpendicular to the magnetic axis orientation.

2) Susceptibility of antiferromagnetic materials is large and negative.

3) The area within the hysteresis loop represents the energy loss per unit volume of material for one cycle.

4) The phenomenon of magnetic moment coupling between adjacent atoms or ions occurs in materials known as ferromagnetism.

5) The paramagnetic substance possesses permanent dipoles due to vanishing angular momentum.

6) A Néel wall is a narrow transition region between magnetic domains.

2. Write short answers. **14**

a) Write short note on magnetic moments of atoms. **4**

b) Explain in brief magnetostatic energy. **5**

c) Distinguish between ferromagnetic and antiferromagnetic orders. **5**

3. a) Show that the susceptibility of diamagnetic substance is temperature independent. **10**

   b) Expalin the domains and domain walls. **4**

4. a) Explain phenomenon of antiferromagnetism and show the inverse variation susceptibility with temperature. **8**

   b) Expalin the gyromagnetic ratio. **6**

5. a) Discuss the Weiss theory of ferromagnetism. **8**

   b) Define Larmor precession. Explain it for magnetic dipoles. **6**

6. a) Explain the origin of crystal anisotropy. **8**

   b) Write short note on magnetic resonance. **6**

7. a) Explain Heigenberg model of molecular field theory. **8**

   b) Expalin in brief anisotropy in hexagonal crystals. **6**

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Seat No.	

M.Sc. – II (Semester – IV) Examination, 2015
PHYSICS (Materials Science)
Paper – XVI : Nano Science and Technology

Day and Date : Thursday, 23-4-2015 Total Marks : 70
Time : 3.00 p.m. to 6.00 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) Figures to the ***right*** *indicate* ***full*** *marks.*
5) ***Use*** *of non programmable calculator is* ***allowed****.*

1. Select the correct alternatives. **14**

1) The hardest material in nature is,

a) Steel b) Topaz c) Diamond d) Quartz

2) The probe of scanning tunneling microscopy is as sharp as

a) An atom at the tip b) Many atoms at the tip

c) A needle d) None of the above

3) What is a bucky ball ?

a) A carbon molecule (C_{60})

b) Nickname for Mercedes-Benz car

c) Plastic explosives nanoparticles

d) Concrete nanoparticles with high compressive strength

4) Which one of these statements is true ?

a) Gold at the nanoscale is red

b) Copper at the nanoscale is green

c) Silicon at the nanoscale is insulator

d) Gold at the nanoscale is yellow

5) What is graphene ?
   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
6) 1 nanometer = _____ cm.
   a) 10^{-9} b) 10^{-8} c) 10^{-7} d) 10^{-6}
7) Fermi level for p-type semiconductor lies
   a) At middle of the band gap b) Close to the conduction band
   c) Close to the valence band d) None of the above
8) Poole-Frenkel effect is present in
   a) Metal b) Insulator
   c) Conductor d) All of the above
9) X-rays which give a line spectrum are called as
   a) Continuous X-rays b) Characteristic X-rays
   c) K X-rays d) Bremstrallung X-rays
10) CBD is relatively _____ technique compared to EBE.
   a) Costlier b) Cheaper
   c) Both a) and b) d) None of the above
11) The wavelength corresponding to the energy 3.02 eV is
   a) 4100 A° b) 410 A° c) 41 A° d) 4.1 A°
12) The main technique used to calculate the band gap of a material is
   a) FTIR spectroscopy b) UV-Vis absorption spectroscopy
   c) NMR spectroscopy d) AAS spectroscopy
13) Scanning electrum microscope is best used to study
   a) Small internal structure b) Surface morphology
   c) Band-gap d) Crystal structure
14) In an electrolytic cell the electrode at which the electrons enter the solution is called the _____ and the chemical change that occurs at this electrode is called _____
   a) Anode, oxidation b) Anode, reduction
   c) Cathode, oxidation d) Cathode, reduction

2. Attempt the following : **14**

   a) Explain Top-down and bottom-up approaches in nanotechnology.

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

   c) Write note on Chemical Vapour Deposition.

3. a) Explain lithographic process with its limitations. Give details of nanolithographic process. **10**

   b) Explain tapping mode in AFM and give its advantages. **4**

4. a) What is elastic and inelastic scattering ? Explain diagrammatically the signal generated by the interaction between electron beam and specimen. **8**

   b) Write a note on Schottky effect and Poole-Frankel effect. **6**

5. a) Explain mechanical structure and components with working of SPM. **8**

   b) Draw schematic of AFM and explain the working of each component. **6**

6. a) Describe the detail experimental procedure for the growth of nanomaterials by Molecular Beam Epitaxy technique. **8**

   b) Explain bright field image and dark field image with proper ray diagram in TEM. **6**

7. a) Explain the conduction in metals, semiconductors in 3D (Bulk), 2D (Thin film) and low-dimensional systems. **8**

   b) Explain working of scanning electron microscope with an appropriate diagram. **6**
