SLR-HK – 9

Seat No.	

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

Day and Date : Saturday, 15-11-2014   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) Heat is _____

　　　a) A property of objects by virtue of their temperature

　　　b) Energy content of the object

　　　c) Energy transfer by virtue of temperature difference

　　　d) Energy transfer by macroscopic work

　　2) According to second law of thermodynamics the energy of the universe
　　　is always _____

　　　a) Conserved　　　　　　　　b) Increasing

　　　c) Decreasing　　　　　　　　d) Fluctuating

　　3) For _____ ensemble $\partial \varrho / \partial T = 0$.

　　　a) Non stationary　　　　　　b) Stationary

　　　c) Vibrating　　　　　　　　　d) All

　　4) For the stable state of the system G i.e. Gibbs's free energy should be
　　　_____

　　　a) Large　　　　　　　　　　b) Small

　　　c) Infinity　　　　　　　　　d) Constant

5) In Bose Einstein condensation all the particle accumulate in _____

   a) Excited state   b) Meta state

   c) Ground state   d) All existing states

6) A the condition for thermal equilibrium is given by _____

   a) $(\partial S_1 / \partial U_1) = (\partial S_2 / \partial U_1)$ b) $(\partial S_1 / \partial N_{i1}) = (\partial S_2 / \partial N_{i2})$

   c) $(\partial S_1 / \partial T_1) = (\partial S_2 / \partial T_1)$ d) $(\partial S_1 / \partial V_1) = (\partial S_2 / \partial V_1)$

7) The chemical potential for photon gas is

   a) Greater than zero   b) Less than zero

   c) Equal to zero   d) Not defined

8) Phase space is _____ dimensional space.

   a) 3N   b) 6N   c) 2N   d) 0N

B) Fill in the blanks/state **True** or **False** :   **6**

   1) Second law of thermodynamics governs the spontaneity of reaction. State **true or false**.

   2) The principle of equi-partition of energy states that the internal energy of gas is shared equally among the molecules. State **true or false**.

   3) In _____ order phase transition heat is evolved or absorbed.

   4) In microcanonical ensemble system exchange both energy and matter. State **true or false**.

   5) The phonons are fermions. State **true or false**.

   6) A quantitative explanation of Brownian motion was given by _____

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

   a) Distinguish between different types of ensemble.

   b) Explain the contacts between statistic and thermodynamics.

   c) Explain the 2nd order phase transition phenomenon with an example.

   d) An ideal gas undergoes an isothermal process starting with a pressure of 2×10^5 Pa and volume of 6 cm^3. Calculate the pressure and volume of the final state.

3. A) Derive Clasius-Clayperon equation for first order phase transition. **10**

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

4. A) How will you explain various statistical distribution functions used in quantum statistical mechanics ? **10**

   B) Write note on phase space and quantum state. **4**

5. A) Explain the theory of cluster expansion for classical gas. **10**

   B) Discuss how Fokker-Plank equation leads to the state of equilibrium. **4**

6. A) Explain the characteristics of canonical ensemble and derive Gibb's distribution function for it. **10**

   B) Explain the P-T diagram of one component system. **4**

7. A) Develop Langevin theory of Brownian motion of particles. Derive Einstein's relation for diffusion coefficient in this case. **10**

   B) 1 kg of water at temperature 30°C is mixed with 2 kg of water at 90°C in a calorimeter of negligible heat capacity at constant pressure of 1 atm. Find the change in entropy of the system. **4**

_____

Seat
No.

M.Sc. (Part – I) (Semester – II) Examination, 2014
METERIALS SCIENCE (Physics)
Quantum Mechanics (Paper – VI)

Day and Date : Tuesday, 18-11-2014　　　　　　　　　　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) An operator operating on an eigen function gives

　　　　a) An eigenvalue and the same eigen function

　　　　b) An eigenvalue and a different eigen function

　　　　c) Another operator

　　　　d) None of the above

　　2) If the length of the one dimensional box is longer, the wavelength at which
　　　　the optical transition occurs is

　　　　a) Shorter　　　　　　　　　　b) Longer

　　　　c) Critical　　　　　　　　　　d) Unaltered

　　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

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 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 gaps : **3**

   1) The wave associated with a particle is called _____ wave.

   2) The molecular orbital theory can explain the _____ of O_2 and NO molecules.

   3) The determinantal form of the wave function 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) Using the Heaviside step function, define Dirac delta function and discuss its properties. **10**

   b) Find the energy jump in electron volts for the emission of visible light of wavelength 7500 A°. **4**

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

   b) The hydrogen halides have the following fundamental vibration frequencies : HF(4141 cm^{-1}), HCl(2989 cm^{-1}), HBr(2650 cm^{-1}), HI(2309 cm^{-1}). Find their force constants in N/cm. (1 N = 10^5 dyne). **4**

5. a) Write down the wave equation for a harmonic oscillator. Give its normalized solutions in terms of Hermite polynomials. Comment on their symmetry property. **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**

6. a) Develop the self-consistent field method to find the energy eigenvalues of atomic orbitals **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**

_____

Seat No.

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

Day and Date : Thursday, 20-11-2014　　　　　　　　　　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.**

1. a) Select the most correct alternatives from the following :　　　　**8**

   i) The emf of cell is 1.3 volt. The positive electrode has potential of 0.5 volt. The potential of negative electrode is _____
      a) 0.8 V　　　　　b) – 0.8 V　　　　c) 1.8 V　　　　d) – 1.8 V

   ii) Which of the following properties is not a function of state ?
      a) Concentration　　　　　　　　b) Internal energy
      c) Enthalpy　　　　　　　　　　d) Entropy

   iii) The number of molecules or atoms whose concentration changes during the chemical reaction is known as _____ of reaction.
      a) Molecularity　　　　　　　　b) Velocity
      c) Order　　　　　　　　　　　d) None of these

   iv) In a colloidal solution, the diameter of dispersed particle is in the range
      a) 10 A° to 100A°　　　　　　　b) 10 A° to 500A°
      c) 10 A° to 1000A°　　　　　　　d) 10 A° to 2000A°

   v) If a salt bridge is removed from the two half cells, the emf of cell
      a) Drops to zero　　　　　　　　b) Does not change
      c) Decreases gradually　　　　　d) Increases gradually

P.T.O.

vi) Mixing of two or more gases is a

    a) Spontaneous process

    b) Non-spontaneous process

    c) Reversible process

    d) None of these

vii) Reactions in which the products of a change react to form the original reactants are known as _____ reaction.

    a) Parallel   b) Chain   c) Opposing   d) Side

viii) Milk is an example of

    a) Sol   b) Gel

    c) Emulsion   d) True solution

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

    i) Any corrosion process can be related to an _____ process.

    ii) The term fugacity has the dimensions of _____

    iii) Order of reaction can have fractional value.

    iv) An emulsion is a colloidal solution of a _____ dispersed in another liquid.

    v) Iron containing impurity of zinc is not corroded.

    vi) The reaction between $K_2S_2O_8$ and KI is an example of _____ reaction.

2. Attempt the following :   **14**

    i) Describe anodic and cathodic protection polarization study.   **5**

    ii) Explain methods determining the rate laws.   **5**

    iii) Write a note on lyophilic and lyophobic sols.   **4**

3. a) Derive Gibb's Helmholtz equations in terms of :   **10**

    i) Free energy and enthalpy and

    ii) Internal energy and work function

  b) Explain the significance of energy of activation.   **4**

4. a) What are potentiometric titrations ? How the acid base titration is carried out potentiometrically ? **10**

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

5. a) What are fuel cells ? Explain hydrogen-oxygen fuel cell. **10**

   b) The rate constant for a chemical reaction at 599K is 1/7th times that at 661K. Calculate the energy of activation (R = 8.314 jk^{-1}mol^{-1}). **4**

6. a) Write hypothesis of Arrhenius equation. Derive mathematical expression of Arrhenius equation. **10**

   b) How the value of A and E is determined from Arrhenius equation ? **4**

7. a) What is partial molar entropy ? How they are determined by calorimetry ? **10**

   b) Write a note on Zinc-Air Fuel Cell (ZAFC). **4**

_____

Seat
No.

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

Day and Date : Saturday, 22-11-2014   Total Marks : 70
Time : 11.00 a.m.to 2.00 p.m.

Instructions : 1) *Q.* **1** *and Q.* **2** *are* **compulsory**.
              2) *Solve* **any three** *questions from Q.* **3** *to Q.* **7**.

1.   **14**

   A) Choose correct alternative :   **8**

     i) In a SEM _____ electrons are detected.
       a) Primary   b) Secondary
       c) Both primary and secondary   d) None of them

    ii) For rhombohedral crystal system γ _____

       a) $\neq 120$ b) $= 90$

       c) $= 120$ d) $\neq 90$

   iii) The accelerating potential for SEM is _____
       a) 25 kV   b) 100 kV
       c) 200 kV   d) 400 kV

   iv) The K.E. of electron in XPS is dependent on _____

       a) Φ of sample   b) Φ of spectrometer
       c) vacuum level of sample   d) vacuum level of spectrometer

    v) _____ is the range of Far IR.
       a) 0.025 – 0.5 mm   b) 0.25 – 5 mm
       c) 0.25 – 0.5 mm   d) 0.025 – 5 mm

   vi) 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

vii) In _____ the light intensity is varied in time domain.

    a) Michelson Morley Interferometer b) Diffraction grating

    c) Prism   d) None of above

viii) IR absorption occurs due to _____

    a) Change in electron configuration b) Symmetric vibrations

    c) Asymmetric vibrations   d) None of above

B) Fill in gaps / State **True** or **False** :   **6**

   i) For hexagonal crystal system $\beta =$ _____

   ii) Number of atoms per unit bcc system is _____

   iii) In _____ mode, of AFM the cantilever is driven to oscillate up and down at near its resonance frequency.

   iv) EDS can process only one photon at a time.

   v) In XPS, photoelectrons are produced using X-rays.

   vi) Number of atoms per unit primitive cell depends on the type of crystal system.

2. Attempt following :   **14**

   1) Write a note on Koopmans theorem.

   2) Find out reciprocal lattice vectors for SC crystal structure.

   3) What is structure factor ? Explain in brief.

3. a) Explain various imaging modes of AFM.   **9**

   b) Explain nanolithography using AFM.   **5**

4. a) Describe basic principle and instrumentation for FTIR system.   **9**

   b) Explain basic principle of Raman Spectroscopy.   **5**

5. a) Explain diffraction of an X-ray beam from a crystal plane and determine condition for constructive diffraction.   **9**

   b) Explain determination of particle size using XRD.   **5**

6. a) Describe basic principle and instrumentation for the UPS system.   **9**

   b) Write a note on sampling depth in XPS.   **5**

7. a) Explain basic principle and instrumentation for SEM.   **9**

   b) Write a note on generation of continuum X-rays.   **5**

_____

Seat
No.

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

Day and Date : Friday, 14-11-2014　　　　　　　　　　　Max. Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

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

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

   1) For a MIS diode system, the capacitance due to _____ is voltage independent.

      a) metal　　　　　　　　　　　b) insulator

      c) semiconductor　　　　　　　d) pn-junction

   2) The dominating operating process for laser is _____

      a) stimulated emission　　　　b) spontaneous emission

      c) absorption　　　　　　　　d) transmission

   3) The interface traps are normally reduced by _____ annealing.

      a) H_2　　　　　　　　　　　b) N_2

      c) O_2　　　　　　　　　　　d) Cl_2

   4) Modern Si-MOSFET's are fabricated on _____ oriented silicon.

      a) $\langle 111 \rangle$　　　　　　　　　b) $\langle 110 \rangle$

      c) $\langle 100 \rangle$　　　　　　　　　d) $\langle 001 \rangle$

   5) For ultra high speed CCD, GaAs is suitable than Si because of _____

      a) high electron mobility　　　b) high electron concentration

      c) low electron mobility　　　d) low electron concentration

P.T.O.

6) Transferred electron devices operate at _____ frequencies.

   a) Hz
   b) KHz
   c) MHz
   d) GHz

7) Figure of merit of a tunnel diode is given as _____

   a) I_P
   b) I_V
   c) $\dfrac{I_P}{I_V}$
   d) $\dfrac{I_V}{I_P}$

8) The effect of gate voltage is to reduce _____ in the SCR operation.

   a) V_{FB}
   b) V_{RB}
   c) Anode current
   d) Holding voltage

9) Transistor model of an SCR fails at _____

   a) $\alpha_1 = 1$
   b) $\alpha_2 = 1$
   c) $\alpha_1 + \alpha_2 = 1$
   d) $\alpha_1 + \alpha_2 = -1$

10) In the saturation region, collector-base junction is
    a) reverse biased
    b) forward biased
    c) does not require bias
    d) none of the above

11) To convert wavelength to photon energy, we use the relation

    a) $\lambda = \dfrac{1.24}{h\upsilon}$
    b) $\lambda = \dfrac{12.4}{h\upsilon}$
    c) $\dfrac{h\upsilon}{12.4}$
    d) $\dfrac{h\upsilon}{1.24}$

12) For a semiconductor that exhibits NDR, any charge imbalance will grow with _____

    a) time constant
    b) voltage
    c) current
    d) time

13) The light modulation band width is given by _____

    a) $\Delta f = \dfrac{\Delta\omega}{2\pi}$
    b) $\Delta f = \Delta\omega \cdot 2\pi$

    c) $\Delta f = \dfrac{2\pi}{\Delta\omega}$
    d) None of these

14) In a CCD, MOS diode array must be biased into _____
    a) slight depletion
    b) depletion
    c) deep depletion
    d) bulk

2. Give a brief account of : **14**

   1) Measurement of interface trapped charges by conductance method. **5**

   2) SCR. **5**

   3) Pin photodiode. **4**

3. a) Discuss the ideal MIS curve referred to energy band diagram, charge, electric field and surface potential. **10**

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

4. a) Discuss the charge storage mechanism referred to MOS diode operating as a CCD device. **10**

   b) What is the effect of density of ionized acceptors on the charge storage mechanism. **4**

5. a) Explain the bidirectional action of a triac and hence its different modes of operation. **10**

   b) Which of the mode is most sensitive ? Why ? **4**

6. a) Explain with the help of a suitable circuit arrangement how can active device be protected from the hazards of $\dfrac{dI}{dt}$ and $\dfrac{dV}{dt}$ effects ? **9**

   b) Write a note on CMOS device. **5**

7. a) Discuss the reverse recovery characteristic of a power diode. **8**

   b) Write a note on enhancement type power MOSFET. **6**

_____

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2014
PHYSICS (Material Science)
Paper – X : Instrumentation

Day and Date : Monday, 17-11-2014   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) All inductance type transducers are based on _____
       a) Faradays laws   b) Seeback effect
       c) Peltier effect   d) Thomson effect

     2) Piezo-electric transducers are _____
       a) Active transducers   b) Inverse transducers
       c) Passive transducers   d) None of the above

     3) DVM measures _____ value.
       a) average   b) r.m.s.
       c) peak-to-peak   d) peak

     4) Principle of Q-meter is _____
       a) Series resonance   b) Parallel resonance
       c) Both a) and b)   d) None of these

     5) The thermo-electric effect was first observed by
       a) Seeback   b) Thomas young
       c) Pirani   d) Thermus

     6) Which bridge is used to determine frequency ?
       a) Anderson bridge   b) De Sauty's bridge
       c) Wein bridge   d) Campell's bridge

     7) The pH value of a solution is defined as
       a) $-\log$ (H^+ ion concentration)   b) $\log$ (H^+ ion concentration)
       c) $-\log^+$(H^+ ion concentration)   d) $-\log$ (OH^- ion concentration)

P.T.O.

8) Which one of the following transducers require power supply for its operation ?

   a) Thermocouple
   b) Photovoltaic cell
   c) Piezoelectric
   d) Thermistor

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

   1) Thermistors have a high negative temperature coefficient of resistance.
   2) In a pH meter, the glass electrode is the reference electrode.
   3) In CRO mostly we use electro-magnetic deflection.
   4) Strain is defined as _____ per unit length.
   5) A neutral solution has a pH of _____
   6) The resolution of a DVM with 4-digit display is _____

2. Attempt the following :

   1) Explain the working of a Resistance Temperature Detector (RTD). **5**
   2) Explain briefly working principle of a digital voltmeter. **5**
   3) Write a note on Sample-Hold circuit. **4**

3. a) Explain the working principle of a D.C. amplifier. **8**

   b) Explain the working principle of a peak-detector. **6**

4. a) State the principle of operation of a dual slope digital voltmeter. **8**

   b) Write a short note on proximity detector. **6**

5. a) Explain basic principle and operation of logarithmic amplifier. **8**

   b) Draw and explain working of the precision half wave rectifier. **6**

6. a) With appropriate circuit diagram, outline the theory of Maxwell bridge for the measurement of an unknown inductance. **8**

   b) What is the basic principle of a Hall-effect transducer ? **6**

7. a) Briefly describe IEEE-488 interface standard. **8**

   b) Write a short note on Q-meter. **6**

_____

Seat No.

M.Sc. – II (Semester – III) Examination, 2014
PHYSICS (Materials Science)
Paper – XI : Elements of Materials Science

Day and Date : Wednesday, 19-11-2014 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 hydrogen bonds is _____ than that of ionic bonds.

      a) Less than b) greater than

      c) equal to d) none of the above

   2) Type of bonding in H_2O is _____

      a) Covalent b) Ionic

      c) Van der Walls d) None of the above

   3) Polymers are materials with _____ molecular weight.

      a) very high b) very low

      c) constant d) none of the above

   4) Electrical resistivity of semiconductors _____ with temperature.

      a) increases b) decreases

      c) do not change d) none of the above

5) If reemission of light occurs for less than a second, the phenomenon is called _____

   a) phosphorescence

   b) radiation

   c) diffraction

   d) fluorescence

6) Zero dimensional nanostructures are _____

   a) Quantum dots

   b) Quantum wells

   c) Quantum wire

   d) None of the above

7) The disordered materials are _____ the solids that can absorb visible light are _____

   a) P-type semiconductors

   b) N-type semiconductor

   c) Both a) and b)

   d) Intrinsic semiconductors

8) Response of Photodiodes is _____ that of photoconductors.

   a) faster than

   b) slower than

   c) equal to

   d) none of the above

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

1) Thermal conductivity of metals is very _____

2) Al_2O_3 is _____ type of material.

3) Physical properties of nanostructures are different than their _____ counterparts.

4) The mobility of GaAs is _____ compared to Si.

5) _____ are the strongest bonds.

6) Energy bandgap of Si is_____

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

   1) What are typical properties of ceramics ?

   2) Discuss classification of polymers.

   3) Write a note CdS as photoconductive cell.

3. a) Discuss with example ionic bonds and hydrogen bonds. **8**

   b) Discuss variation in conductivity of doped semiconductors with temperature. **6**

4. a) What are the different types of compound semiconductors ? Give examples. **6**

   b) Derive an expression for thermal equilibrium electron concentration in n-type semiconductors. **8**

5. a) What is the role of traps in controlling the optical properties of solids ? **8**

   b) What do you mean by colour centers ? Explain with one example. **6**

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

   b) Write a short note on electroluminescence. **8**

7. a) Discuss the factors controlling the performance of photodetectors. **8**

   b) Which properties of nanostructures are important for their commercial applications ? Explain with one example. **6**

_____

Seat No.	

M.Sc. (Part – II) (Semester – III) Examination, 2014
PHYSICS (Materials Science)
(Paper No. – XII) Dielectric and Ferroelectric Materials

Day and Date: Friday, 21-11-2014   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 the correct alternative :   **6**

   1) The amplitudes of electric and magnetic fields are related to each other by the relation
      a) $E_o B_o = C$ b) $B_o = E_o C$ c) $E_o = B_o C$ d) $E_o B_o = C^2$

   2) When a negative charge is placed at the centre of the sphere then the direction of electric field on the Gaussian surface is
      a) Radially outward   b) Radially inward
      c) Along the tangent to the surface   d) None of these

   3) Fluorescence occurs within
      a) $10^{-5} 5$ b) $10^{-5} ms$ c) $10^{-5} \mu s$ d) $10^{-5} ns$

   4) According to wave theory, the velocity of electromagnetic waves in any dielectric medium _____
      a) $C = \dfrac{1}{\mu_o \in}$ b) $C = \dfrac{1}{\mu \in}$ c) $C = \mu \in$ d) $C = \dfrac{1}{\sqrt{\mu \in}}$

   5) Solar cell works based on
      a) Laser technology   b) Photo-conduction
      c) Thermal emission   d) Tyndall effect

   6) Piezoelectric effect is the production of electricity by
      a) Chemical effect   b) Pressure
      c) Varying field   d) Temperature

                                                                                        P.T.O.

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

1) Polarization in a dielectric on application of electric field is the displacement of opposite charge centres.

2) With increase in temperature, the orientation polarization in general increases.

3) Refractive index of materials is approximately equal to square root of electrical permittivity.

4) The Maxwell's equation which remains unchanged when a medium changes is $\nabla \cdot \overline{B} = 0$.

5) Luminescence is because of knocking out of electrons by photons.

6) In intrinsic semiconductor, there are as many free electrons as there are holes.

7) The spontaneous polarization for ferroelectric material is zero above curie temperature.

8) Mobility of electron is average flow of electrons per unit field.

2. Write short answers : **14**

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

2) Explain in brief anomalous photovoltaic effect. **5**

3) Explain in brief Photo Electron-Magnetic (PEM) effect. **4**

3. a) Derive an expression for local field for nondipolar material. **10**

   b) Write the word statement of Maxwell's equations. **4**

4. a) Discuss in detail the photovoltaic behaviour of P-N junction. **10**

   b) Enlist any four applications of photovoltaic cell. **4**

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

   b) What are the uses of ferroelectric capacitors ? **4**

6. a) State and prove Onsager relations. **10**

   b) Enlist the types of dielectric polarization. **4**

7. a) Discuss in detail the temperature dependance of complex permittivity. **10**

   b) Define ferroelectricity and give its types. **4**

———————

M.Sc. (Part – II) (Sem. – IV) Examination, 2014
PHYSICS (Material. Sci.) (New)
Paper – XIII : Computational Methods and Programming

Day and Date : Saturday, 15-11-2014   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** to Q. **7**.
4) **Use** of nonprogrammable calculator is **allowed**.

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

   i) A _____ analysis may be regarded as a process to develop and evaluate the methods for computing required mathematical numerical results from the given numerical data.

     a) graphical   b) statistical

     c) numerical   d) none of these

   ii) A fitting of curve of type $xy = b + ax$, then normal equations are

     a) $\sum\left(\dfrac{b}{x}+a\right)=na+b\sum\left(\dfrac{1}{x}\right),\ \sum\left(\left(\dfrac{1}{x}\right)\left(\dfrac{b}{x}+a\right)\right)=a\sum\left(\dfrac{1}{x}\right)+b\left(\sum\left(\dfrac{1}{x}\right)\right)^{2}$

     b) $\sum\left(\dfrac{b}{x}-a\right)=na+b\sum\left(\dfrac{1}{x}\right),\ \sum\left(\left(\dfrac{1}{x}\right)\left(\dfrac{b}{x}-a\right)\right)=a\sum\left(\dfrac{1}{x}\right)+b\left(\sum\left(\dfrac{1}{x}\right)\right)^{2}$

     c) $\sum\left(\dfrac{b}{x}+a\right)=na-b\sum\left(\dfrac{1}{x}\right),\ \sum\left(\left(\dfrac{1}{x}\right)\left(\dfrac{b}{x}+a\right)\right)=a\sum\left(\dfrac{1}{x}\right)-b\left(\sum\left(\dfrac{1}{x}\right)\right)^{2}$

     d) none of these

iii) The square root of 'a' can be considered a root of the equation, $x^2 - a = 0$, solvable by Newton's method, formula for this is

a) $x_{n+1} = \dfrac{1}{2}\left(x_n - \dfrac{a}{x_n}\right)$

b) $x_{n+1} = \dfrac{1}{2}\left(x_n + \dfrac{a}{x_n}\right)$

c) $x_{n+1} = \dfrac{1}{2}\left(x_n + \dfrac{x_n}{a}\right)$

d) none of these

iv) The _____ error is caused by replacing the tabulated function by means of an interpolating polynomial.

a) truncation   b) rounding off

c) truncation and rounding off   d) none of these

v) Errors involved in numerical calculation are _____ errors.

a) iterative   b) approximation

c) rounding off   d) all of these

vi) Regula-Falsi is _____ convergent while Newton's method is conditionally convergent.

a) rarely   b) never   c) surely   d) conditionally

vii) $\Delta^n [x]^n = $ _____

a) $(n-1)!$ b) $(n+1)!$ c) $n!$ d) none of these

viii) The order of convergence of the _____ method is 1.618.

a) Bisection   b) Regula Falsi

c) Iteration   d) Newton-Raphson

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

i) A great advantage of Euler's method lies in the fact that if dy/dx changes rapidly over an interval, at the beginning it give a better approximation.

ii) The nth divided differences of a polynomial of nth degree are constant.

iii) Δ obeys distributive, commutative and index laws.

iv) $\Delta = E - 1$ or $E = 1 + \Delta$ where, E is _____

v) The process of finding the value of y corresponding to any value of $x = x_i$ between x_0 and x_n is called _____

vi) Putting $n = 3$ in general quadrature formula and taking the curve through limits as a polynomial of degree one so that differences of an order higher than one vanish, we get _____ formula.

2. Attempt following : **14**

i) Show that rate of convergence for Newton Raphson method is quadratic.

ii) Find a real root of the equation $x\log_{10}x = 1.2$ by Regula-Falsi method correct to four decimal places.

iii) What are the advantages of Monto-Carlo method in computational methods ?

3. A) Using Runge Kutta method, obtain a solution of the equation **10**

$$\frac{dy}{dx} = xy + \left| \sqrt{x} \right| = f(x, y)$$

with initial condition $y = 1$ at $x = 0$ for the range $0 \le x \le 0.3$ in steps of 0.1.

B) What is Pivoting ? When it done ? Explain. **4**

4. A) Write a algorithm for predictor-corrector method for solution of differential equation. **8**

B) Using Jocobi's iterative method solve following simultaneous equations : **6**
$- 2x + 3y + z = 9$, $3x + 4y - 5z = 0$, $x - 2y + z = - 4$.

5. A) For two random variables, x and y with the same mean, the two regression equations are **8**

$y = ax + b$ and $x = \alpha y + \beta$ show that $\dfrac{b}{\beta} = \dfrac{1-\alpha}{1-\beta}$.

B) Use the trapezoidal rule for 6 ordinates, and for 11 ordinates, to estimate the

integral $\int_0^1 e^x \, dx$, correct to four decimal places and comment on the result. **6**

6. A) Construct the forward difference table, given that and point out the values
   of $\Delta^2 y_{10}$, $\Delta^4 y_5$. **6**

x	5	10	15	20	25	30
y	9962	9848	9659	9397	9063	8660

   B) Show that : **8**

   i) $\delta = \dfrac{1}{2}\left(E^{\frac{1}{2}} + E^{-\frac{1}{2}}\right)$

   ii) $\mu = \dfrac{1}{2}\left(E^{\frac{1}{2}} + E^{-\frac{1}{2}}\right)$

   iii) $E = e^{hD}$

   iv) $\Delta = E - 1$.

7. A) Fit an equation of the form $y = ae^{bx}$ to the following data by the method of
   least squares. **6**

x	1	2	3	4
y	1.65	2.7	4.5	7.35

   B) Using the Lagrange method of interpolation, find the unique polynomial P(x)
   of degree 2 such that :

   P(1) = 1, P(3) = 27, P(4) = 64. **8**

———————————————

SLR-HK – 18

<table>
<tr><td>Seat
No.</td><td></td></tr>
</table>

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

Day and Date : Saturday, 15-11-2014　　　　　　　　　　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) If the stability factor is $g = 1 - j\omega\delta t$, the stability condition is _____

   　　a) $1 - \delta t^2 \omega^2 \leq 1$ 　　　　　　　　b) $1 + \delta t^2 \omega^2 \leq 1$

   　　c) $1 - \delta t^2 \omega^2 \geq 1$ 　　　　　　　　d) $1 + \delta t^2 \omega^2 \geq 1$

   ii) The equation $\dfrac{dy}{dt} + 10y = 0$ represents an equation of _____

   　　a) Exponential decay　　　　　　b) Exponential growth
   　　c) Oscillations　　　　　　　　　d) None above

   iii) Damped harmonic oscillator obeys differential equation of the form
   _____

   　　a) $a\dfrac{d^2y}{dx^2} - b\dfrac{dy}{dx} + cy = 0$ 　　　　b) $a\dfrac{d^2y}{dx^2} - b\dfrac{dy}{dx} - cy = 0$

   　　c) $a\dfrac{d^2y}{dx^2} + b\dfrac{dy}{dx} + cy = 0$ 　　　　d) None of these

   iv) Schmidt explicit formula is valid for _____
   　　a) Any value of α 　　　　　　　　b) $0 < \alpha \leq 1$
   　　c) $0 < \alpha \leq \dfrac{1}{2}$ 　　　　　　　　d) None of the above

P.T.O.

v) It matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 2 & 5 \\ 0 & 0 & 3 \end{bmatrix}$ then the eigen values of A^{-1} are _____,

_____, _____

    a) $1, {}^1\!/_2, 1/3$ b) $1, 2, 3$

    c) $2, {}^1\!/_2, 3$ d) $1, 3, 1/2$

vi) In solving simultaneous equation by Gauss Jordon method the coefficient matrix is reduced to _____ form.

    a) null   b) diagonal

    c) square   d) hermitian

vii) If $K = 75$, the maximum value generated by the random function random (K) will be _____

    a) 75   b) 76

    c) 74   d) 750

viii) Which of the following equation is parabolic ?

    a) $f_{xy} - f_x = 0$ b) $f_{xx} + 2f_{xy} + f_{yy} = 0$

    c) $f_{xx} + 2f_{xy} + 4f_{yy} = 0$ d) None of the above

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

    i) For Gaussian elimination step, the time taken to solve N equations in N unknowns is proportional to _____

    ii) Methods which generate random number depend on a _____ sequence.

    iii) A matrix with $A_i, i \neq 0$ and $A_i, i \pm 1 \neq 0$ is known as _____

    iv) The eigen value of a skew symmetric matrix are real.

    v) Truncation error in simple algorithm method is second order in time but third order in space.

    vi) To use Adam's Bashforth predictor-corrector method at least four values of y, prior to the desired value are required.

2. Attempt following :   **14**

    i) How Monte-Carlo method could be used to determine an average value of a statistic f(x) ?

    ii) Write short note on the Leap-Frog method.

    iii) Determine first four values for the equation.

    $\dfrac{dy}{dt} + 10y = 0$; Given $y_0 = 1$.

3. a) Express general form of first order ODE and solution y(t). What do you mean by boundary conditions. Thus explain Runga-Kutta to numerically solve the ODE.   **10**

    b) Discuss properties of pseudo random number series ; $X_{n+1} = \dfrac{X_n xa}{b}$.   **4**

4. a) Discuss Euler's method to obtain solution of ordinary differential equation and write its algorithm.   **10**

    b) Write an algorithm to find inverse of a matrix.   **4**

5. a) What do you mean by itterative method for solving the matrix equation

    Ax = b ?

    Explain the Gauss-Seidal Method.   **10**

    b) How the Jacobi method is implemented by Gauss-Seidel method ?   **4**

6. a) Obtain solution of Laplace equation $\nabla^2 u = 0$ using finite difference approximation.   **10**

    b) Explain Eulerian and Langragian method.   **4**

7. a) Determine X_1 to X_6 of a pseudo random numbers series.

    Given : $X_1 = 1$, a = 13, b = 5.   **6**

    b) Using Gauss-Elimination method solve following set of simultaneous equations;

    $3x_1 - 0.1x_2 - 0.2x_3 = 7.85$

    $0.1x_1 + 7x_2 - 0.3x_3 = -19.3$

    $0.3x_1 - 0.2x_2 + 10x_3 = 71.4$ **8**

_____

Seat No.

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

Day and Date : Tuesday, 18-11-2014   Total Marks : 70
Time : 3.00 p.m. to 6.00 p.m.

Instructions : 1) Attempt **any 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 disadvantage of pn-junction isolation is _____

      a) smaller isolation time   b) effective diffusion

      c) parasitic diffusion   d) parasitic capacitance

   ii) Buried layer fabrication is an essential condition for the fabrication of
   _____

      a) diode   b) capacitor

      c) transistor   d) resistor

   iii) _____ photoresist is specially developed for LSI and VLSI applications.

      a) Iso fine Kodak – 820

      b) Kodak micropositive – 820

      c) Hunt Way HPR – 256

      d) Novolac

   iv) Ion implantation energy is of the order of _____

      a) very large   b) very small

      c) several KeV to MeV   d) few KeV to MeV

v) The most modern high frequency transistors are fabricated by _____ only.

   a) Diffusion

   b) Epitaxy

   c) Combination of a) and b)

   d) Subsequent processes

vi) Etch attacks are preferentially faster on a _____ oriented silicon.

   a) (110)   b) (100)   c) (111)   d) (101)

vii) The laws of diffusion are derived especially for _____ diffusion.

   a) Substitutional

   b) Interstitial

   c) Combinational

   d) Interchange

viii) In the zone process, the length of a typical zone is _____ cm.

   a) 15 cm

   b) 0.15 cm

   c) 0.015 cm

   d) 1.5 cm

ix) Base diffusion in transistors is usually carried out by _____ source diffusion.

   a) constant

   b) instantaneous

   c) both a) and b)

   d) subsequent diffusion

x) Czochalarski technique works on the principle of _____

   a) controlled freezing

   b) controlled heating

   c) controlled polymerization

   d) controlled oxidation

xi) Boron has a diffusion coefficient of _____ cm^2/sec.

   a) 10^{-12} b) 10^5 c) 10^8 d) 10^{-8}

xii) Snow – Plow is due to diffusion of _____ into silicon.

   a) Boron

   b) Phosphorus

   c) Arsenic

   d) Indium

xiii) Silicon oxide layer acts as a _____ electrode in MOS devices.

   a) drain

   b) source

   c) shield

   d) gate

xiv) Planar diodes are generally _____ adopted for the operation.

   a) simple diodes

   b) thyristors

   c) transistors

   d) capacitors

2. Write a short note on **any three** : **14**

   a) Ion implantation

   b) Fabrication of diffused resistors

   c) Ficks 2nd law of diffusion

   d) Show that (111) plane in silicon is closest of all.

3. a) Discuss the various steps in the fabrication of a standard IC. **10**

   b) Compare CMOS with that of the bipolar technology. **4**

4. a) Write a note on fabrication of an nϕn-transistor (monolithic) referred to impurity profile. **8**

   b) Explain how does the integrated transistor differ from the discrete. **6**

5. a) Discuss the various growth conditions and parameters for the fabrication of an epitaxial layer. **10**

   b) What is a thin film resistor ? **4**

6. a) Give a brief account of substitutional diffusion. **8**

   b) Write a note on oxide formation. **6**

7. Attempt the following : **14**

   a) What is redistribution during growth ? **5**

   b) Evaluation of an epilayer. **5**

   c) Mention the characteristics of a good photoresist. **4**

_____

Seat No.	

M.Sc. (Part – II) (Semester – IV) Examination, 2014
PHYSICS (Materials Science) (Paper – XI)
Magnetic Materials

Day and Date : Thursday, 20-11-2014   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) When an electromagnet has an iron core inserted, what happens to the strength of the magnet ?

      a) It increases

      b) It remains the same

      c) It decreases

      d) Since it depends on the metal used in the wires of the electromagnet

   2) 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

   3) Typical size of magnetic domains is

      a) 5 mm   b) 0.1 mm

      c) 0.05 mm   d) 0.001 mm

   4) Example for anti-ferro-magnetic materials

      a) Salts of transition elements   b) Rare earth elements

      c) Transition metals   d) Ferrites

5) The inverse magnetostrictive effect is also known as

   a) Curie effect

   b) Neel effect

   c) Weiss effect

   d) Villari effect

6) The primary source of magnetocrystalline anisotropy is

   a) Spin motion

   b) Orbital motion

   c) Spin-orbit interaction

   d) None of these

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

   a) Bloch wall

   b) Neel wall

   c) Curie wall

   d) Weiss wall

8) At zero field strength, the magnetization is offset from the origin by an amount called _____

   a) Coercivity

   b) Remanence

   c) Magnetization

   d) Magnetic moment

b) Fill in gaps/**True** or **False** :   **6**

   1) The relationship between field strength H and magnetization M is linear in ferromagnetic materials.

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

   3) The magnetostriction can be positive like in pure iron or negative like in nickel.

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

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

   6) Domains exist even in absence of external field.

2. Write short answers : **14**

   a) Distinguish between dia and para-magnetic materials. **5**

   b) Define Hall coefficient. **5**

   c) What do you meant by magnetic moments of atoms ? **4**

3. a) Show that the susceptibility of diamagnetic substance is temperature independent. **8**

   b) State the principle of search coil and give applications. **6**

4. a) Give the classical treatment of paramagnetism. **8**

   b) Explain why susceptibility of diamagnetic substance is negative ? **6**

5. a) Derive an expression for Hall coefficient and give the merits of Hall effect. **8**

   b) Explain the ferri and antiferromagnetic orders. **6**

6. a) Explain the symmetry of multiferroic domain walls. **8**

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

7. a) Discuss the physical origin of magnetostriction. **8**

   b) Explain Anisotropic Magnetoresistance (AMR) in polycrystalline ferromagnetic materials. **6**

_____

Seat No.

M.Sc. (Part – I) (Semester – I) Examination, 2014
MATERIAL SCIENCE (Physics) (Paper – I)
Mathematical Techniques (New)

Day and Date : Friday, 14-11-2014   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) 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 Cauchy Rieman equations are _____

   A) $u_x = v_y$ and $v_x = u_y$　　　　　B) $u_x = -v_y$ and $v_x = u_y$

   C) $u_x = v_y$ and $v_x = -u_y$　　　　D) $u_x = u_y$ and $v_x = v_y$

   ii) A function u is said to be Harmonic if it satisfy

   A) $u_{xx} + v_{yy} = 0$　　　　　　　B) $u_{xy} - v_{xy} = 0$

   C) $u_{xx} - v_{yy} = 0$　　　　　　　D) None of these

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

   A) degree of differential equations

   B) order of differential equations

   C) no. of terms on LHS of differential equations

   D) total no. of terms of the differential equation

   iv) Matrix digitalization of symmetric matrix is possible only if it has

   A) repeated eigen values　　　　　　B) non-repeated eigen values

   C) non zero eigen values　　　　　　D) zero eigen values

v) The Fourier series of f(x) in (– a, a) will involve _____ if f(x) is odd.

   A) only cosine terms   B) constants

   C) both sine and cosine terms   D) only sine terms

vi) The vectors X_1, X_2 and X_3 are said to be orthogonal if _____

   A) $X_1.X_2 = 0$, $X_2.X_3 = 0$, and $X_3.X_1 = 0$

   B) $X_1.X_2 = 1$, $X_2.X_3 = 1$, and $X_3.X_1 = 1$

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

   D) None of the above

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

  i) Both real and imaginary parts of an analytic functions are Harmonic.

  ii) Fourier series of the function exists if it satisfy Dirichlets condition.

  iii) Laplace transform is derived from Integral transform by taking t < 0.

  iv) *Cosecx* can be expressed as Fourier series in $(-\pi, \pi)$.

  v) Fourier Sine transform of $\dfrac{1}{x}$ is $\sqrt{2/\pi}$.

  vi) If $L\{f(t)\} = \phi(s)$ then $L\{e^{at}f(t)\} = \phi(s+a)$.

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

  viii) A differential equation is said to be linear if the independent variable is having degree atmost one.

2. Write short notes on :

  a) State and Prove De Moivers Theorem.   **5**

  b) Define Linear dependence and Independence of the vectors.   **4**

  c) Write a note on integral Transform.   **5**

3. a) Show that the function e^x(cos y + i sin y) is an analytic function, and hence find its derivative. Prove that real and imaginary parts of the above function are harmonic.   **8**

  b) Find the eigen values and eigen vectors corresponding to negative eigen values.

$$\begin{pmatrix} 1 & 1 & -2 \\ -1 & 2 & 1 \\ 0 & 1 & -2 \end{pmatrix}$$ **6**

4. a) Solve $(1+x)^2 \dfrac{d^2y}{dx^2} + (1+x)\dfrac{dy}{dx} + y = \sin 2[\log(1+x)]$ **6**

   b) Find the Fourier Series of $f(x) = x^2$ in $[0, 2\pi]$. **8**

5. a) Find Laplace transform of $e^{-4t} \displaystyle\int_0^t u \sin 3u\, du$. **8**

   b) Use Cauchy Integral formula to evaluate $\displaystyle\int_C \dfrac{e^2 z}{(z+1)^2}\, dz$ where C is the circle

   $|z| = 2$. **6**

6. a) Define Adjoint of the matrix. Hence find A^{-1} of the matrix using adjoint matrix

   method for $\begin{pmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{pmatrix}$. **8**

   b) Solve $(D^2 - 4D + 4)\, y = 8(x^2 + \sin 2x + e^{2x})$. **6**

7. a) Express the function $f(x) = \begin{cases} 1, & |x| < 1; \\ 0, & |x| > 1 \end{cases}$

   Hence evaluate $\displaystyle\int_0^\infty \dfrac{\sin \omega \sin \omega x}{\cos \omega}\, d\omega$. **8**

   b) Evaluate the integral using Laplace transform method $\displaystyle\int_0^\infty \dfrac{e^{-at} - e^{-bt}}{t}\, dt$. **6**

_____

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

Day and Date : Monday, 17-11-2014   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 alternatives :   **8**

    1) Numbers of tetrad axis in simple cubic system are _____

      a) 2   b) 3   c) 4   d) 8

    2) Coordination number in case of BCC structure is _____

      a) 8   b) 6   c) 10   d) 12

    3) Plane parallel to negative x-axis have the miller indices _____

      a) 011   b) 001   c) 110   d) 100

    4) Penetration depth (λ) is given by the relation _____

      a) $\dfrac{\lambda_0}{(1-t^2)}$ b) $\dfrac{\lambda}{(1-t^2)}$ c) $\dfrac{\lambda}{(1-t^4)}$ d) $\dfrac{\lambda_0}{(1-t^4)}$

    5) The Fermi Energy (E_F) in case of p-type semiconductor at T = 0 K is _____

      a) $\dfrac{E_V+E_A}{2}$ b) $\dfrac{E_c+E_d}{2}$ c) $\dfrac{E_A-E_V}{2}$ d) $\dfrac{E_c+E_a}{2}$

    6) Elemental solid dielectric has only _____ polarization.

      a) Electronic   b) Ionic   c) Orientational   d) All

    7) Ewald sphere is drawn with a radius _____

      a) a   b) a/λ c) λ d) $1/\lambda$

    8) Intrinsic concentration of charge carriers in a semiconductor varies as _____

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

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

1) In an ionic polarization electronic cloud is coming to one side.

2) FCC structure contains the contribution of four atoms.

3) Lattice constant is double the atomic radius.

4) Conductivity in metal depends on electron mobility.

5) In monoclinic lattice a, b, c and α, β and γ are not equal.

6) According to mass action law product of hole and electron concentration is unequal.

2. Attempt following :   **14**

1) What is critical current ? Explain Silsbee's rule.   **5**

2) Symmetry operations.   **5**

3) Dielectric loss.   **4**

3. a) What is Josephson's effects ? Show that for identical superconductor

$$\frac{d}{dt}(\theta_2 - \theta_1) = 0 .$$ **10**

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

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

b) Calculate electronic polarizability of an isolated Se atom of atomic radius 0.12 nm. Given : $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m.   **4**

5. a) Explain HCP, FCC crystal structures in detail.   **8**

b) For a simple cubic crystal, calculate the number of atoms per square mm for the atomic planes (010), (110) and (111).   **6**

6. a) What is intrinsic semiconductor ? Calculate the concentration of holes in valance band of intrinsic semiconductor.   **10**

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

7. a) Explain the behaviour of electron in periodic potential.   **10**

b) Explain Brillion zone.   **4**

––––––––––––––

SLR-HK – 3

<table>
<tr><td>Seat
No.</td><td></td></tr>
</table>

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

Day and Date : Wednesday, 19-11-2014　　　　　　　　　　　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. Objective questions : **14**

   a) Select correct alternatives : **6**

   1) The unity gain bandwidth of 741 OPAMP is typically

      a) 4 MHz　　　　　　　　　　　b) 2 MHz

      c) 6 MHz　　　　　　　　　　　d) 1 MHz

   2) The number of pins of the IC741 op-amp is

      a) 8　　　　　b) 12　　　　　c) 16　　　　　d) 24

   3) For which of the following flip-flops, the output is clearly defined for all combinations of two inputs

      a) D type flip-flop　　　　　　　b) R-S flip-flop

      c) J-K flip-flop　　　　　　　　d) None of these

   4) A device which converts BCD to Seven Segment is called

      a) Encoder　　　　　　　　　　b) Decoder

      c) Multiplexer　　　　　　　　　d) Demultiplexer

   5) Data bus is _____

      a) Unidirectional　　　　　　　b) Bi-directional

      c) tridirectional　　　　　　　　d) none of these

   6) The 8085 microprocessor has _____ number of flags.

      a) 4　　　　　b) 5　　　　　c) 16　　　　　d) 10

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

P.T.O.

1) Why is input offset voltage applied to an op-amp ?

2) Why is the square-generator called as a stable multivibrator ?

3) The output voltage of a summing amplifier is proportional to the sum of the input voltages.

4) Convert XOR gate into inverter.

5) Design AND gate using 2×1 mux.

6) DeMorgan's first theorem shows the equivalence of.

7) Can ROM be used as stack ?

8) 8085 is a 16-bit processor.

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

   a) Constant current bias.   **5**

   b) Master Slave JK Flip-flop.   **5**

   c) Write an assembly language program to find biggest element in an array using $8085 \mu p$ instructions.   **4**

Long Answer Questions :   **42**

3. a) What is an instrumentation amplifier ? Explain with neat diagram.   **10**

   b) Explain the difference between inverting and differential summing amplifier.   **4**

4. a) With neat circuit diagram explain Wein bridge oscillator using op-amp.   **8**

   b) Write a brief note on switching regulators.   **6**

5. a) Using a suitable logic diagram explain the working of a 1-to-16 demultiplexer.   **8**

   b) With relevant logic diagram and truth table explain the working of a two input EX-OR gate.   **6**

6. a) What do you understand by a race around condition ? Draw the circuit diagram of D flip flop and explain its operation.   **6**

   b) Using D flip flops and waveforms explain the working of a 4-bit SISO shift register.   **8**

7. a) Draw the pin diagram of 8085 and explain the functions of each pin.   **8**

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

————————————

SLR-HK – 4

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) If $\dfrac{\partial L}{\partial q_n} = 0$, where L is the Lagrangian for a conservative system without

      constraints and q_n is a generalized coordinate, then the generalized
      momentum p_n is
      a) An ignorable coordinate   b) Constant
      c) Undefined   d) Equal to Hamiltonian of the system

   2) A particle of mass m on the Earth's surface is confined to move on the
      parabolic curve $y = ax^2$, where y is up. Which of the following is the Lagrangian
      of the particle ?

      a) $L = \dfrac{1}{2} m\dot{y}^2 \left(1 + \dfrac{1}{4ay}\right) - mgy$ b) $L = \dfrac{1}{2} m\dot{y}^2 \left(1 - \dfrac{1}{4ay}\right) - mgy$

      c) $L = \dfrac{1}{2} m\dot{x}^2 \left(1 + \dfrac{1}{4ax}\right) - mgy$ d) $L = \dfrac{1}{2} m\dot{y}^2 \left(1 + \dfrac{1}{4ay}\right) + mgy$

3) How many degrees of freedom two particle system can have ?

   a) 6   b) 3   c) 2   d) 9

4) Which of the following statement or statements is or are true ?

   a) Force of constraint does no work in any possible displacement

   b) Force of constraint does work in any possible displacement

   c) If the constraint depends on time, then force of constraint is not zero in any possible displacement

   d) Even if the constraint depends on time, then also force of constraint is zero in any possible displacement

5) Suppose that the gravitational force law between two massive objects were

$$\vec{F} = \frac{\hat{r}_{12}\, Gm_1 m_2}{r_{12}^{\,2+\varepsilon}},$$ where ε is a small positive number. Which of the following statement would be false ?

   a) The total mechanical energy of the planet sun system would be conserved

   b) The angular momentum of a single planet moving about the sun would be conserved

   c) A single planet could move in a stationary non circular elliptical orbit about the sun

   d) A single planet could move in a stationary circular orbit about the sun

6) Which of the following defines a conservative force F ?

   a) $dF/dt = 0$ b) $\nabla . F = 0$

   c) $\nabla \times F = 0$ d) $\oint F.dr \neq 0$

7) A block of mass m sliding down an inclined at constant speed in initially at a height h above the ground. The coefficient of kinetic friction between the mass and the incline is μ. If the mass continues to slide down the incline at a constant speed, how much energy is dissipated by friction by the time the mass reaches the bottom of the incline ?

   a) mgh/μ b) mgh   c) $Mgh\sin\theta$ d) Zero

8) Poisson Bracket are _____ under canonical transformation.

   a) Variant   b) Nullified

   c) Anti-symmetric   d) Invariant

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

   1) Scleronomic constraint do not explicitly depends on time.

   2) Generalized coordinates are dependent on one another.

   3) The area swept out by the radius vector per unit time is constant.

   4) In a central motion the orbit of a particle always lie in a plane which is parallel to the fixed direction of angular momentum.

   5) The transformation is canonical if pdq – PdQ is an exact differential.

   6) q_j's which are absent in L are called cyclic coordinates.

2. Write short answers **any three** :   **14**

   a) A shell of mass 12 Kg is fired with muzzle velocity of 400 m/s at an angle of elevation 45°.   **4**

   a) Find range use g = 10 m/s².

   b) When it is at the highest point of the trajectory, it splits into two halves because of the internal explosion. One half lands at a point 20 km on x-axis from origin. Where will the other half lands and when ?

   b) Prove that forces acting on a particle are conservative then the total energy E of a particle is conserved.   **5**

   c) Show that the momentum conservation theorems are closely connected with the symmetry properties of the system.   **4**

   d) What are the degrees of freedom needed to describe a double pendulum oscillating in vertical plane. Explain briefly.   **5**

3. a) Derive Lagrange's equation of motion. **8**

   b) Write Lagrange's equation of motion for a particle moving in 3 D under potential V(x, y, z). **6**

4. a) Derive Canonical equations of Hamilton. Also write the procedure for constructing Hamiltonian. **8**

   b) Obtain Hamilton's equation for one dimensional simple harmonic oscillator. **6**

5. a) What is Poisson Bracket ? Write all the properties of Poisson Bracket. **8**

   b) Show that $Q = \sqrt{2q} \ e^a \cos P$ and $P = \sqrt{2q} \ e^{-a} \sin P$ is a canonical transformation. **6**

6. a) Derive and explain the classification of orbits. **8**

   b) Obtain the conservation theorems using Lagrange's equation of motion. **6**

7. a) Show that central force motion of two bodies about their centre of mass can always be reduced to an equivalent one body problem. **8**

   b) Write a note on D'Alembert's Principle. **6**

_____

Seat No.

M.Sc. (Part – I) (Semester – I) Examination, 2014
PHYSICS (Materials Science) (Old)
Condensed Matter Physics (Paper – II)

Day and Date : Monday, 17-11-2014   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 width of energy gap in a superconductor at 0°K is nearly

   i) k_BT_C ii) $35\,k_BT_C$
   iii) $3.5\,k_BT_C$ iv) $300\,k_BT_C$

   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 inter planar 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 c/a ratio for an ideal hexagonal closed packed structure is

   i) $\dfrac{2}{\sqrt{3}}$ ii) $\sqrt{8}$ iii) $\sqrt{5}$ iv) $\sqrt{\dfrac{8}{3}}$

   5) The effective mass of an electron in a semiconductor

   i) can never be positive   ii) can never be negative

   iii) can be positive or negative   iv) depends on its spin

   6) Diamond structure is composed of

   i) two S.C   ii) a S.C. and F.C.C.

   iii) two F.C.C.   iv) none of these

   7) Below critical temperature, the superconductor behaves as _____ material.

   i) magnetic   ii) ferromagnetic

   iii) paramagnetic   iv) diamagnetic

8) A lattice is characterized by following primitive vectors $\vec{a} = 2(\hat{i} + \hat{j})$,

$\vec{b} = 2(\hat{j} + \hat{k}), \vec{c} = 2(\hat{k} + \hat{i})$. 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) The packing fraction of F.C.C. structure is _____
   ii) The depletion region in an open circuited p-n junction contains _____
   iii) The first Brillion zone lies between _____ of k value.
   iv) Volume of primitive cell of bcc structure having conventional lattice parameter a 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. Attempt the following :   **14**
   i) How energy bands are formed ? Explain with examples in detail.   **5**
   ii) What is meant by polarization in dielectrics ? Obtain the relation between the dielectric constant and atomic polarizability. **5**
   iii) Derive the London equations and explain the term coherence length. **4**

3. a) Write short notes on the followings :   **8**
      i) Reduced zone schemes.   ii) Fermi surfaces.
   b) Write a note on Josephson effect.   **6**

4. a) What is meant by dielectric loss ? Discuss the mechanism that leads to electric breakdown. **8**
   b) Explain what is meant by N and P type semiconductors.   **6**

5. a) Derive the susceptibility expression for ferromagnetic material.   **10**
   b) In a p-type semiconductor, the Fermi level lies 0.4 eV below the valance band. If the concentration of the acceptor atom is tripled, find the new position of the Fermi level. **4**

6. a) Write a note on thermodynamics of superconductor.   **8**
   b) Give a brief account of Type II superconductors.   **6**

7. a) How is the cooper pairs formed ? Explain the BCS theory of superconductivity. **7**
   b) Discuss the behavior of an electron in a periodic potential.   **7**

_____

Seat No.

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

Day and Date : Wednesday, 19-11-2014   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**.*
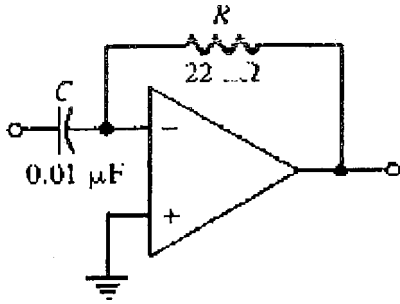*3) Figures to the **right** indicate full marks.*

14

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

   1) Output impedance of an ideal op-amp is

      a) Infinite   b) Very high   c) Low   d) Zero

   2) An oscillator whose frequency is changed by a variable d.c. voltage is known as

      a) Crystal Oscillator

      b) A voltage controlled oscillator

      c) An Armstrong Oscillator

      d) Piezoelectric Device

   3) The Boolean expression $X = AB + CD$ represents _____

      a) Two ORs ANDed together   b) A 4-input AND gate

      c) Two ANDs ORed together   d) An exclusive -OR

   4) A feature that distinguishes the J K Flip Flop from the R S Flip Flop

      a) Toggle condition   b) Preset input

      c) Types of clock   d) Clear input

   5) What is the total phase shift requirement, around the feedback loop, for a phase-shift oscillator ?

      a) 90°   b) 180°   c) 270°   d) 360°

6) ROM is a _____

    a) Nonvolatile memory   b) Volatile memory

    c) Read/write memory   d) Byte organized memory

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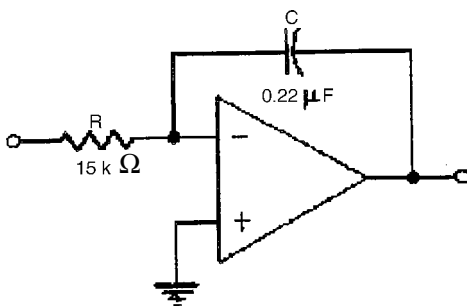

    a) A non inverting amplifier   b) A differentiator

    c) An integrator   d) A summing amplifier

8) The minimum number of Flip-Flops required for a synchronous decade counter is

    a) 1   b) 2   c) 4   d) 10

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

    i) R S flip-flop does not accept the input entry when _____

    ii) The AND operation can be produced with _____

    iii) A modulus-12 counter must have _____

    iv) In a microprocessor, the register which holds the address of next instruction to be fetched is _____

    v) A phase shift oscillator has three _____ circuits.

    vi) Refer to the figure given below. This circuit is known as _____

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

   1) Astable multivibrator

   2) Instrumentation amplifier

   3) Time division multiplexing

   4) CMRR frequency response.

3. a) Draw the schematic diagram of an ideal non-inverting OP-AMP with voltage shunt feedback and derive the expression for the voltage gain.   **8**

   b) Explain the ideal differential amplifier.   **6**

4. a) Explain the principle and operation of phases shift oscillator with suitable circuit diagram.   **8**

   b) Explain with proper diagram dual input balanced output differential amplifier.   **6**

5. a) Using LM 317, design an adjustable voltage regulator to satisfy the following specifications ; Output voltage V_0 = 12 Volt to 15 Volt and output current I_0 = 0.50 ampere and draw the complete schematic diagram.   **8**

   b) Describe triangle wave generator.   **6**

6. a) Explain the basic concepts of synchronous and asynchronous counters and draw the circuit and Timing Diagram of Asynchronous Counter.   **8**

   b) Explain the D Flip-Flop with proper diagram.   **6**

7. a) What is Microprocessor ? Explain the requirement of a program counter, stack pointer and status flags in the architecture of 8085 microprocessor.   **8**

   b) Write an assembly language program to find out the largest number from given unordered array of 8 bit numbers, stored in the locations starting from a known address.   **6**

———————