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End Semester Examination of Semester–I, 2015
Subject : ELECTRONICS (HONS.) (UG)
Paper : I
Full Marks : 40
Time : 2 Hrs

The figures in the margin indicate the marks corresponding to the question.

Candidates are requested to give their answers in their own word as far as practicable.

Illustrate the answers whenever necessary.

Group A

Answer **any two** from the following questions : 10x2=20

1. a) Prove that

$\vec{F}=\left(y^2\cos x+z^3\right)\hat{i}+\left(2y\sin x-4\right)\hat{j}+\left(3xz^2+2\right)\hat{k}$ is a conservative force field. 3

b) Find the scalar potential for $\vec{F}$. 2

c) Find the work done in moving an object from $(0, 1, -1)$ to $(\frac{\pi}{2}, -1, 2)$ 2

d) Show that in any irreversible process entropy change of the universe is always positive. 3

2. a) What do you mean by Internal energy of a thermodynamic system? Is it a state function? What is the change in the Internal energy due to expansion of a an ideal gas adiabatically from (P_0, V_0) to (P, V). 1+1+3

b) Consider a Mole of ideal gas. Show that the change in entropy of the gas is an isothermal reversible process from volume V_A to V_B is

$$S(V_B,T)-S(V_A,T) = R\ln\left(\frac{V_B}{V_A}\right).$$ 3

c) Sketch the Carnot Cycle is P–V and T–S diagram. 1+1

3. a) A shower of 5000 molecules each moving with the same velocity originally, traverses a gas. Compute the number that would travel undeflected, even after traversing a distance equal to 0·5 times the mean free path and also a distance equal to the mean free path. 3

b) Silver crystallizes with fcc lattice. Calculate the number of silver atoms unit cell of the lattice. Assuming the atoms to touch along surface diagonals of the unit cell, find the atomic radius in terms of the lattice constant a and hence determine the percentage of unit cell volume, actually occupied by silver atoms. 4

c) KBr has cubic structure. If its density is $2{\cdot}75\times10^3$ Kg m^{-3} and its molecular weight = 119·01, calculate the lattice constant.

4. a) What is extrinsic semiconductor? Explain its nature with energy band diagram for both n and p-type materials. 4

b) Show that the average kinetic energy per electron for a three dimensional free electron gas at 0K is where is the Fermi energy at 0K is $E_0 = \frac{3}{5}E_{F0}$ where E_{F0} is the Fermic energy at 0K. 3

c) Sketch a comparative diagram for Fermi distribution function at $T = 0$ and $T > 0$ and explain what the sketch signifies for the both conditions. 3

Group B

Answer **any two** from the following questions : 5x2

5. Find the eigen values and eigenvectors of the Matrix

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

Is the Matrix Unitary? 4+1

6. Using Berthelot's equation of state

$$P = \frac{RT}{V-b} - \frac{a}{TV^2}$$

find the form of critical constants V_c, P_c, T_c in terms of a, b and R.

7. Derive an expression for the interplanar separation of the (h k l) planes of a simple cubic crystal. Draw (101) plane for the crystal. 3+2

8. Explain the origin of the intrinsic potential barrier across the p–n junction. On which factors does the width of the depletion layer depend? Can you measure the potential barrier across a p–n junction diode with a voltmeter connected across the junction? Explain. 2+1+2

Group C

Answer **any five** from the following questions : 2×5

9. A scalar function $\phi(x, y, z) = xy^2 + yz^3$. Find the component of $\vec{\nabla}\phi$ at the point (2, –1, 1) in the direction of vector $\hat{i}-2\hat{j}+2\hat{k}$.

10. Find the condition to make the following differential equation exact.
$(ay^2 + x^2 + x^8)dx + (y^8 - y + bxy)dy = 0$.

11. Pauli matrices are given by

$$\sigma_x = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \quad \sigma_y = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_z = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

which of the Pauli matrices are Hermitian?

12. Plot the isotherms of a pure substance near critical temperature. Indicate the region of coexistence of liquid and gaseous phase in that diagram.

13. A reversible engine converts $\frac{1}{3}$th of the heat input to work. If the temperature of the sink is reduced by 62^0C its efficiency is doubled. Find the temperature of the source and sink.

14. Are all quasi-static process reversible? Justify.

15. Give the Physical interpretation of entropy.

16. Derive Bragg's law from Lane Equation.

17. Explain the basic principle of a LDR.

18. The band gap of a specimen of gallium arsenide phosphate is 1·98 eV. Determine the wavelength of the electromagnetic radiation that is emitted upon direct recombination of electrons and holes in this sample.