# B.Tech Even Semester Examination, May, 2025

## Agricultural Engineering / Electronics & Communication Engineering

(2nd Semester)

**Course No: ASHP-151**

*(Physics-I)*

*Full Marks: 70*
*Pass Marks: 28*
*Time: 3 hours*

**Note:**

1. Attempt any five questions taking one from each unit.
2. Begin each answer in a new page
3. Answer parts of a question at a place
4. Assume reasonable data wherever required
5. The figure in the right margin indicates full marks for the question
6. All the mathematical symbols and abbreviations have their usual meanings.

### UNIT-I

1. (a) Show that $\vec{\nabla} r^n = nr^{n-2}\vec{r}$, where $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$. 5

   (b) If $\vec{A} = 2xz^2\hat{\imath} - yz\hat{\jmath} + 3xz^3\hat{k}$, find $\vec{\nabla} \times \vec{A}$ at the point $(1,1,1)$ 5

   (c) If $\vec{A} = x^2z\hat{\imath} - 2y^3z^2\hat{\jmath} + xy^2z\hat{k}$, Find $\vec{\nabla}.\vec{A}$ at the point $(1,-1,1)$ 4

2. (a) What is central force? 3

   (b) State Kepler's laws of planetary motion. 6

   (c) Set up the differential equation for the orbit of a planet in the gravitational field of the sun. 5

## UNIT-II

3. (a) Describe in detail the different types of the crystal system. 8

   (b) The silver at room temperature is FCC with atoms of atomic radius 0.144 nm. Calculate the lattice constant ($a$) for the cube edge of the silver unit cell. 2

   (c) Write a short note on Bragg's law. 4

4. (a) What are crystal defects? Discuss various types of crystal defects. 2+8

   (b) What are Miller indices? 2

   (c) Calculate the Miller indices of crystal planes which cut through the crystal axes at 3a, 6b, 9c. 2

## UNIT-III

5. (a) State Heisenberg's uncertainty principle. 3

   (b) Show that the group velocity of the de Broglie wave associated with the moving particle travels with same velocity as the particle. 6

   (c) Why cannot free electrons exist in atomic nuclei? Explain in detail. 5

6. (a) Derive an expression for the time-independent Schrodinger wave equation. 6

   (b) A particle is free to move one dimensionally in a region of zero potential between two rigid walls at x=0 and x=L, (i) Find the wave function of the particle in the nth state. (ii) Show that the energy of the particle varied as the square of the natural numbers. 5+3

## UNIT-IV

7. (a) What is free electron theory? 2

   (b) What is meant by Fermi energy? Calculate its value for the free electron gas at 0K. 1+5

   (c) The atomic radius of Sodium is 1.88 A. Calculate the Fermi energy at 0K. 6

8. (a) Write short notes on

   (i) Photons (ii) Phonons 4+4

   (b) The Fermi energy of Lithium is 4.72 eV at T= 0K. Calculate the number of conduction electrons per unit volume in the lithium, given the mass of electron $9.11\times10^{-31}$ kg and Plank's constant = $6.63\times10^{-34}$JS. 4

   (c) What are the factors which affect the value of the conductivity of materials? 2

## UNIT-V

9. (a) Derive an expression of the density of electrons in the conduction band of an intrinsic semiconductor. 9

   (b) Derive an expression of the current density of the intrinsic semiconductors. 5

10. (a) Write a short note on extrinsic semiconductors. 4

    (b) Derive the law of mass action for semiconductors. 6

    (c) Obtain the expression of Fermi level with the temperature in the intrinsic semiconductor. 4

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