LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
Accredited by NAAC & NBA (CSE, IT, ECE, EEE & ME)
Approved by AICTE, New Delhi and Affiliated to JNTUK, Kakinada
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FRESHMAN ENGINEERING DEPARTMENT

Assignment

UNIT IV QUANTUM MECHANICS & FREE ELECTRON THEORY

1	Explain de- Broglie hypothesis. OR Define matter waves? Explain their properties.
2	State and explain Heisenberg's uncertainty principle.
3	Interpret the significances of wave function.
4	Derive Schrodinger time independent wave equation.
5	Derive Schrodinger dependent wave equation.
6	Discuss the particle in a one dimensional potential well and determine the energy and wave equation of a free particle.
7	Explain the classical free electron theory of metals with advantages and drawbacks.
8	Derive the conductivity of a metal based on quantum free electron theory.
9	What is a Fermi level? Explain the Fermi-Dirac distribution function for electrons in a metal. Discuss the variation with temperature.
10	Derive an equation for density of energy states in a material.

Problems

1	Estimate the de- Broglie wavelength associated with an electron with energy 2000 eV.
2	Calculate the wavelength associated with an electron raised to a potential of 1600 V and 100 V.
3	Estimate the velocity and kinetic energy of an electron of wavelength 1.66×10^{-10} m.
4	An electron is bound in a one dimensional infinite well having a width of $1 \times 10^{-10}\ m$ .Estimate the energy values in the ground state and the first three excited states.

5	An electron is bound in a one dimensional box having size of $4 \times 10^{-10}\ m$. What will be its minimum energy.
6	An electron is confined to a in a one dimensional potential box of $2A^0$ length. Estimate the energies corresponding to the second and fourth quantum states(in eV).
7	Find the temperature at which there is 1% probability that a state with energy 0.5 eV is above Fermi energy.
8	At what temperature we can expect a 10% probability that electrons in silver have energy which is 1% above the Fermi energy? The Fermi energy of silver is 5.5 eV .
9	The following data given for copper: i) Density $= 8.92 \times 10^3\ kgm^{-3}$ (iii) Resistivity $=1.73 \times 10^8\ \Omega m$ and ii) Atomic weight = 63.5. Estimate the mobility and the average time collision of electrons in copper obeying classical laws.
10	Calculate the electrical resistivity of sodium at 0^0C.It has 25.33×10^{27} electrons per unit volume and has a mean free time of $3.1 \times 10^{14}\ s$.
11	The relaxation time of conducting electrons in a material is $3 \times 10^{-14}\ s$. If the density of electron is $5.8 \times 10^{28}\ electrons\ per\ m^3$ .Find the resitivity of the material and mobility of the electron.
12	A uniform silver has a resistivity $1.54 \times 10^{-8}\ \Omega m$ at room temperature. For an electric field along the wire of 1 volt/cm, compute the average drift velocity of an electron assuming that there is $5.8 \times 10^{28}\ electrons\ per\ m^3$ .Also calculate the mobility.

Constants:

Mass of electron $= 9.1 \times 10^{-31}\ kg$

Planck's constant $= 6.626 \times 10^{-34} Js$

Charge of electron $= 1.6 \times 10^{-19} C$

$$1\ eV = 1.6 \times 10^{-19} J$$