VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Electronics Engineering

WS_2023-24 (CAT-II)

Course Code	: BEVD101L	**Duration**	: 90 Minutes.
Course Name	: Electronic Materials		
Faculty Name	: Kittur Harish Mallikarjun		
Slot	: B1+TB1	**Max. Marks**	: 50M

Instructions: Answer all the questions

	Question	Mark
Q1	Given a rectangular tunnel barrier of height 2 eV and width 2 nm. Consider electrons of energy 0.75 eV are incident on the barrier. Calculate:	2+2+ 3+3
	i. The propagation constant of the electron wave function before and after the barrier	
	ii. The attenuation constant of the electron wave function in the barrier	
	iii. The transmission coefficient of the barrier to the electrons incident on them.	
	iv. Comment on what would happen to each of the above if the height of the barrier is increased to 3 V?	
Q2	Consider a hydrogenic atom with Z =3 (Li^{2+} ion). Assume a_0 = 0.08 nm.	6+4
	i. Write down the wavefunction of the state with the quantum numbers: n = 2, l = 1 and m_l = 1.	
	ii. Calculate the energy difference between the 2s and the 4p states of the atom.	
Q3	Consider electron in a harmonic potential well of depth 7 eV having a force constant of β = 300 Nm^{-1}. Calculate the zero-point energy and also the energies of the bound states of the electron in the well.	5+5
Q4	Consider a hypothetical material in which the density of electron states in the conduction band is given by $g(E) = 4 \times 10^{23} (E-E_C)$ cm^{-3}. Where E_C is the bottom of the conduction band. Assume that the Fermi level E_F is 0.2 eV below the conduction band edge E_C. At T = 300 K, calculate:	2+3+ 2+3
	i. the number of electron per unit energy of the band at the band edge E_C	
	ii. the number of electron per unit energy of the band at the energy E = 10^{-4} eV above the E_C	
	iii. the number of electron per unit energy of the band at the energy E = 10^{-3} eV above E_C	
	iv. At what E above E_C do you expect to find the maximum number of electrons per unit energy of the band, justify.	
Q5	Consider a chain of N = 10^3 atoms of mass M = 3 amu, joined end to end. Given that the distance between the atoms is 0.7 angstrom units and the force constant between the atoms is 9.1 Nm^{-1}, calculate the group velocity of the q = 2 mode of phonons in the lattice. Also calculate the momentum and energy of the corresponding phonon modes in the chain. Given 1 amu = 1.627×10^{-27} kg.	6+4

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