বাংলাদেশ আর্মি ইন্টারন্যাশনাল ইউনিভার্সিটি অব সায়েন্স এন্ড টেকনোলজি (বিএআইইউএসটি), কুমিল্লা

BANGLADESH ARMY INTERNATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY (BAIUST), CUMILLA

Department of Electrical and Electronic Engineering
Level-4, Term-I
Mid Term Examination, Spring-2023
Course Code: EEE 413
Course Title: Solid State Devices

Time: 1 Hour
Full Marks: 60

Notes:

a. Each question carries 30 marks.

b. Figure on the right of each question indicate marks for respective question.

<u>Answer any two questions including question no.1</u>

1. **a.** Explain why the value of wavefunction is zero outside infinite potential well? **(5)**

b. From time independent Schrodinger's equation, deduce the expression of wave function $\Psi(x)$ for an electron trapped in an infinite potential well shown in Fig :Q1(b) mentioning the main considerations while deriving the solution. **(13)**

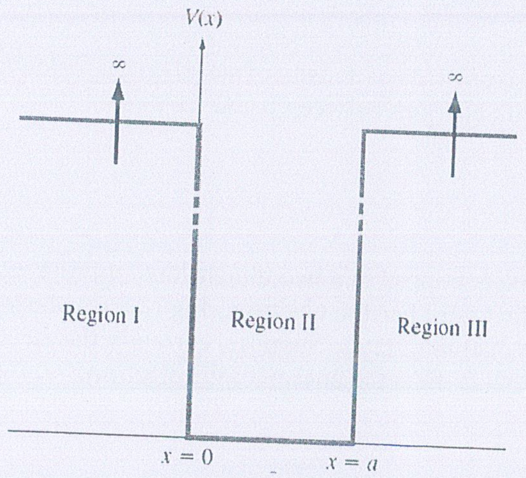

Fig : Q1(b)

c. Consider the following figure at Fig : Q1(c).
The probability of finding a particle at a distance d in region II compared with that at x = 0 is given by exp $(-2k_2d)$. Consider an electron traveling in region I at a velocity of 10^5 m/s incident on a potential barrier whose height is three times (3×) the kinetic energy of the electron. Calculate the probability of finding the electron at a distance d compared with x = 0 where d is (a) 10 Å and (b) 100 Å into the potential. **(12)**

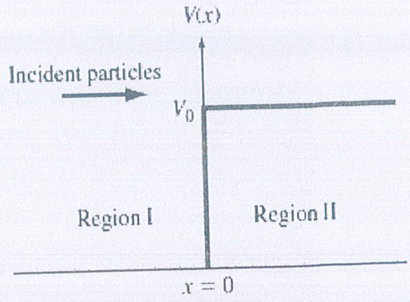

Fig : Q1(c)

2. a. Considering a free electron confined to a three-dimensional infinite potential well, derive the expression of density of states per unit volume as a function of energy (g(E)) and show that **(14)**

$$g(E) = \frac{4\pi(2m)^{3/2}}{h^3}\sqrt{E}$$

b. Using the expression of density of states (g(E)), calculate the density of states per unit volume with energies between 0 and 1 eV. **(8)**

c. An electron is trapped in a two dimensional infinite well.of dimension a= 5 Å in both x and y direction. For the electron,, Fig : Q2(c) shows the two dimensional array of allowable quantum states. Suppose, currently the electron is the state A as marked in the Fig : Q2(c). Find the energy of the electron. **(8)**

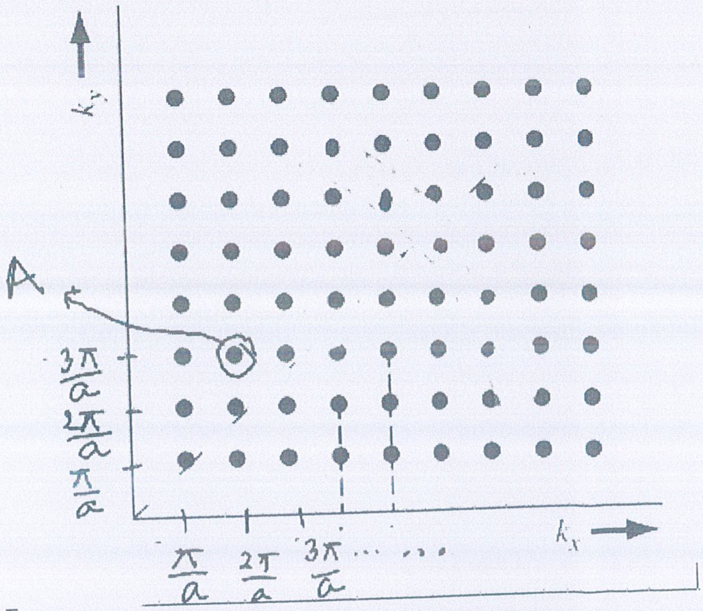

Fig : Q2(c).

3. a. Draw a diagram of Electron energy vs interatomic distance for $_6C$ atom and show how conduction and valence band forms by combination and splitting of 2s and 2p states. **(10)**
(Indicate no of states and no of electrons in the diagram)

b. Write down the expression for fermi probability function (f(E)) and qualitatively plot it against energy (E). Also, show how the graph changes with the variation of temperature. **(8)**

c. Assume the Fermi energy level is 0.30 eV below the conduction band energy Ec. Assume T = 300 K. (a) Determine the probability of a state being occupied by an electron at E = Ec + kT/4. (b) Repeat part (a) for an energy state at E = Ec + kT. **(12)**

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