Arab Academy for Science & Technology & Maritime Transport
(AASTMT – Cairo Branch)
College of Engineering & technology
Electronics & Communication Engineering Department

Course : Solid State Electronics
Course Code : EC210

Sheet #9

TextBook
'Principles of Electronic Materials and Devices', Third Edition, S.O. Kasap © McGraw-Hill, 2006

Constants:
$\varepsilon_o = 8.85\times10^{-12}\,\text{Fm}^{-1}$
Charge of electron $(q) = 1.6\times10^{-19}\,\text{C}$
Mass of electron $(m_e) = 9.1\times10^{-31}\,\text{kg}$
Plank's Constant $(h) = 6.63\times10^{-34}\,\text{Js}$

Solve the following problems

[1] If the energy (E) verus the wave number (k) relation of electrons in one dimensional crystal is given by E(k)=2 – cos(ka) where a is the distance between every 2 atoms (i.e. periodic potential well period):

a. Plot the E-k diagram between $k=-\frac{\pi}{a}$ to $\frac{\pi}{a}$ radians/m.

b. Calculate the group velocity at k=0, $\frac{\pi}{a}$ r/m.

c. Calculate the effective mass at k=0, $\frac{\pi}{a}$ r/m.

[2] For silicon, in the <100> direction, the energy referenced to conduction band edge can be described as: $E = A\,k^2$.
and if the measurements show that the effective mass of electrons in the <100> direction is $0.916m_o$, find the constant A.

[3] For a $1\mu m^3$ Si material, find the maximum allowed number of electrons in the conduction band which can be present between E1=1eV and E2=2eV at T= 200K, 300K and 400K. Assume m* = 0.92mo.

[4] Calculate the Density of States for a 2D material, following the same procedure used in 3D material.