10/12/07

ECE 495N, Fall'07 MSEE B010, MWF 330P – 420P

Fundamentals of Nanoelectronics

HW#5: Due Friday Oct.19 in class.

All exercises, page numbers refer to

S.Datta, Quantum Transport: Atom to Transistor, Cambridge (2005)

HW#5: Due Friday Oct.19 in class. None of these problems require the use of MATLAB.

Problem 1: Exercise E.5.4, Page 128.

Problem 2: Consider an infinitely long linear 1-D lattice (lattice constant: a) with one s-orbital per atom (assumed orthogonal) and having a site energy of E_0, so that the Hamiltonian looks like

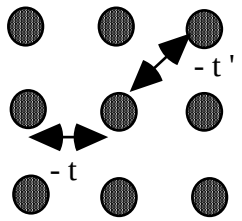
$$H = \begin{bmatrix} \varepsilon & te^{i\varphi} & 0 & 0 & \cdots \\ te^{-i\varphi} & \varepsilon & te^{i\varphi} & 0 & \cdots \\ 0 & te^{-i\varphi} & \varepsilon & te^{i\varphi} & \cdots \\ \cdots & \cdots & \cdots & & \end{bmatrix}$$

Impose periodic boundary conditions and assume a solution of the form $\phi_n = \phi_0 e^{ik\,na}$ to find the dispersion relation E(k).

Problem 3: The $E(k_X,k_Y)$ relation for a two-dimensional solid is written in the form

$$E = E_0 - 2V(\cos k_x a + \cos k_y a + 2\alpha \cos k_x a \cos k_y a)$$

where α is a dimensionless number. How would you choose the nearest neighbor and next nearest neighbor overlap matrix elements in a square lattice of side 'a' so as to correspond to this dispersion relation ?



Nearest neighbor overlap : - t

Next nearest neighbor overlap : - t'