Department of Physics and Astronomy
College of Science, King Saud University Riyadh

Mid Semester Exam
2nd Semester 1428-1429 H

Solid State Physics, **Phys 570**

Time: two hours **Maximum marks- 25**

Answer all questions. Q.1 and 2 carry 10 marks each and Q 3 carry five marks.

Q.1.

(a) A quantum mechanical treatment of valence electrons confined in three dimension volume V leads to density of state

$$D(E) = D_0 E$$

Where, $D_0 = (2m^2V)/(\pi^2h^4)$

Find the expression for the Fermi energy E_F in terms of electron density, n.

(b) Quantum mechanics tells that the energy of an electron of mass m in one dimension of length L is given by

$$E_n = (h^2n^2)/(8mL^2)$$

Where n is 1,2,3 ……
Consider a linear chain of 6 atoms equally spaced at distance of "a". One electron can be detached from its parent atoms. If each electron is allowed to move through out the all atoms. Derive the expression for the energy of the highest occupied level at T= 0K.

Q2. The energy of an electron in linear chain of atoms of uniform spacing a is given by

$E(k) = \varepsilon_o [1-\cos(ka)]$ where ε_o is positive constant.

(a) Plot E(k) as function of k in the first Brillouin zone.
(b) Calculate the acceleration of the electron due to the constant force F and plot it in the first Brillouin zone.

Q3.

(a) How many numbers of independent energy levels are in an energy band of N atoms?
(b) What is hole? Write its momentum, energy and effective mass with respect to those of electron.
(c) Explain direct and indirect energy band gap in semiconductors.

End