

HW # 5

- ① CALCULATE THE DENSITY OF STATES $g(E)$ FOR A 2-DIMENSIONAL ELECTRON GAS (2DEG), IN A 2DEG, ELECTRONS ARE ALLOWED TO MOVE IN TWO DIMENSIONS, BUT NOT THE THIRD. AN EXAMPLE OF THIS IS A QUANTUM WELL, WHERE ELECTRONS ARE CONFINED IN THE Z-DIRECTION, BUT NOT X OR Y.

HINT: ASSUME EACH QUANTIZED ENERGY HAS ITS OWN D.O.S. THE TOTAL D.O.S IS THE SUM OF EACH LEVELS D.O.S.

- ② WHAT ARE THE D.O.S. m_n^* and m_p^* FOR Si?

- ③ IMAGINE A QW DEFINED BY INFINITE BARRIERS AND A WIDTH OF 100nm. IF THE MATERIAL IS GaAs, AND YOU HAVE 13 ELECTRONS IN THE SYSTEM, WHAT IS THE FERMI ENERGY?
FOR 20 ELECTRONS?
FOR 150 ELECTRONS?

④ WHAT IS THE IONIZATION ENERGY (IN eV) OF A PHOSPHORUS DONANT IN Si?

ASSUMING A BOLZEMANN DISTRIBUTION OF ENERGY, AT WHAT TEMPERATURE WOULD THE P ATOM HAVE A 850 PROBABILITY OF BEING IONIZED?

⑤ WHAT ARE N_v , N_c FOR GaAs AT 300K?

WHAT ARE THE CARRIER CONCENTRATIONS (n_0, p_0) FOR

a) $E_c - E_f = 1 \text{ eV} ?$

b) $E_c - E_f = 0.7 \text{ eV} ?$

and

c) $E_c - E_f = 0.2 \text{ eV} ?$

⑥ IF I DOPED A Si WAFER WITH 10^{17} Boron atoms, and assuming the atoms are 100% ionized, ~~WHAT ARE~~ WHERE IS THE FERMI LEVEL IN THIS SYSTEM?