The University of Windsor

ELEC2250: Physical Electronics

Summer 2020

Lab Three

Fermi – Dirac Distribution Function

Friday, June 26, 2020

Emmanuel Mati

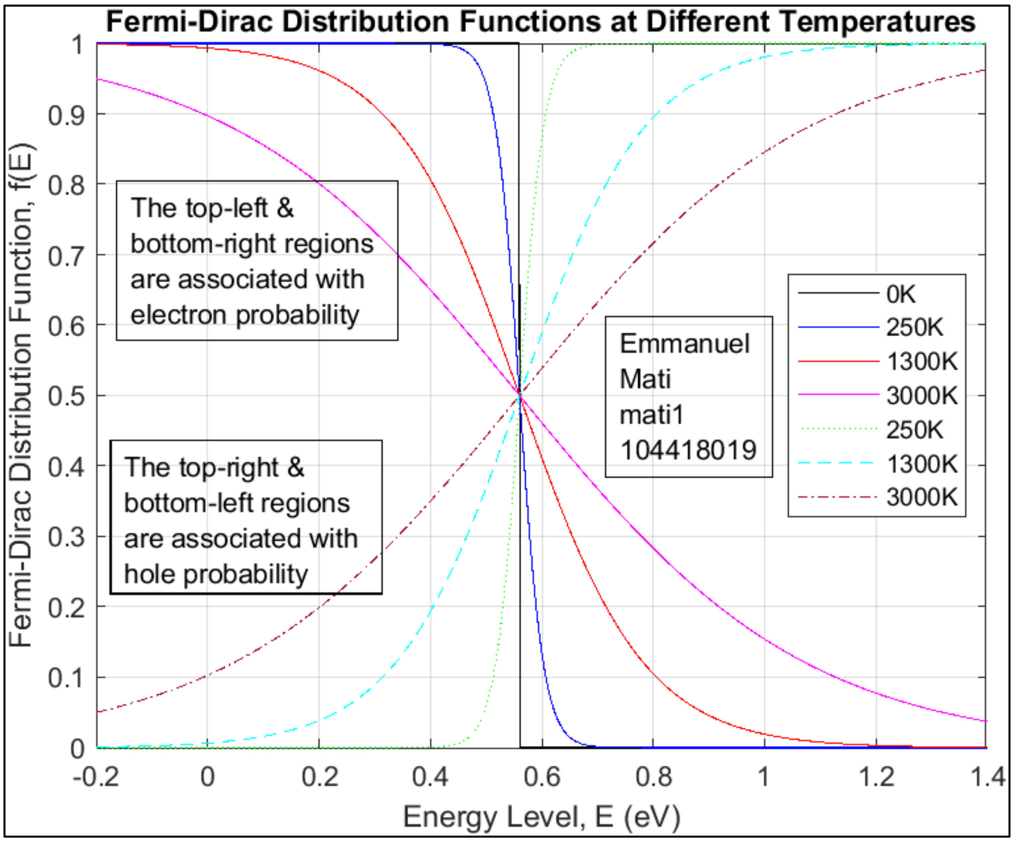
104418019

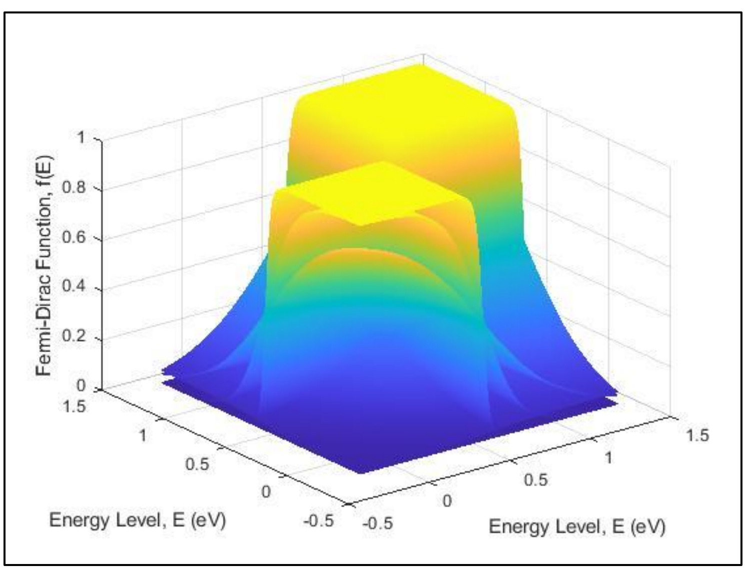
Observations

Q 1: Incorporates pt. 4 by using a wide range, pt. 6's hole concentrations, and pt. 8/9 labelling

E(f) = 0.56

Temps: 250k, 1300k, 3000k

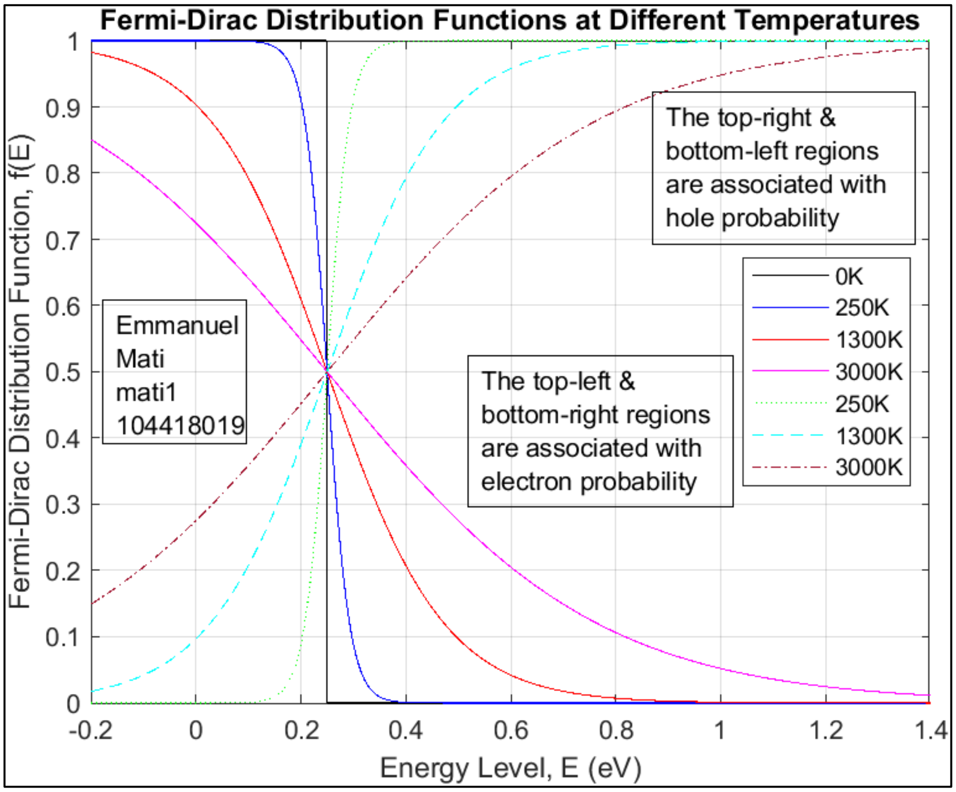


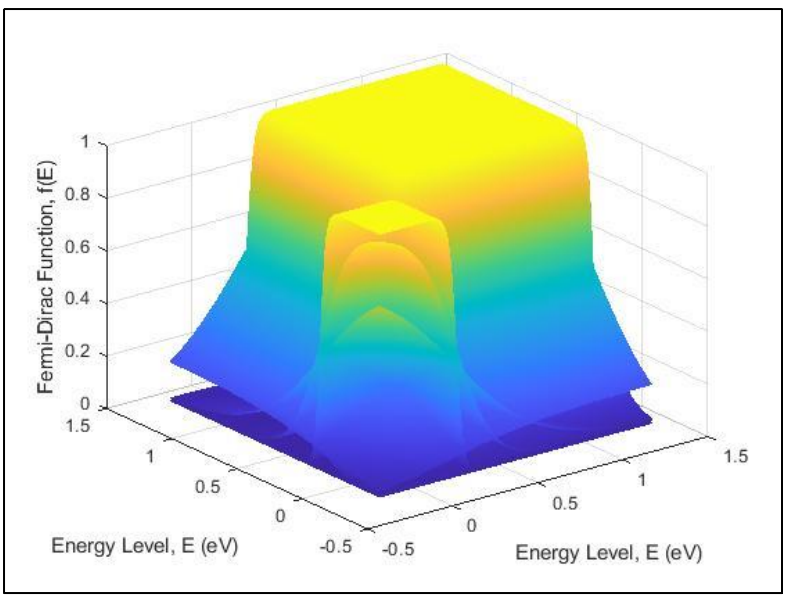


Q 2: Incorporates pt. 4 by using a wide range, pt. 6's hole concentrations, and pt. 8/9 labelling

E(f) = 0.25

Temps: 250k, 1300k, 3000k

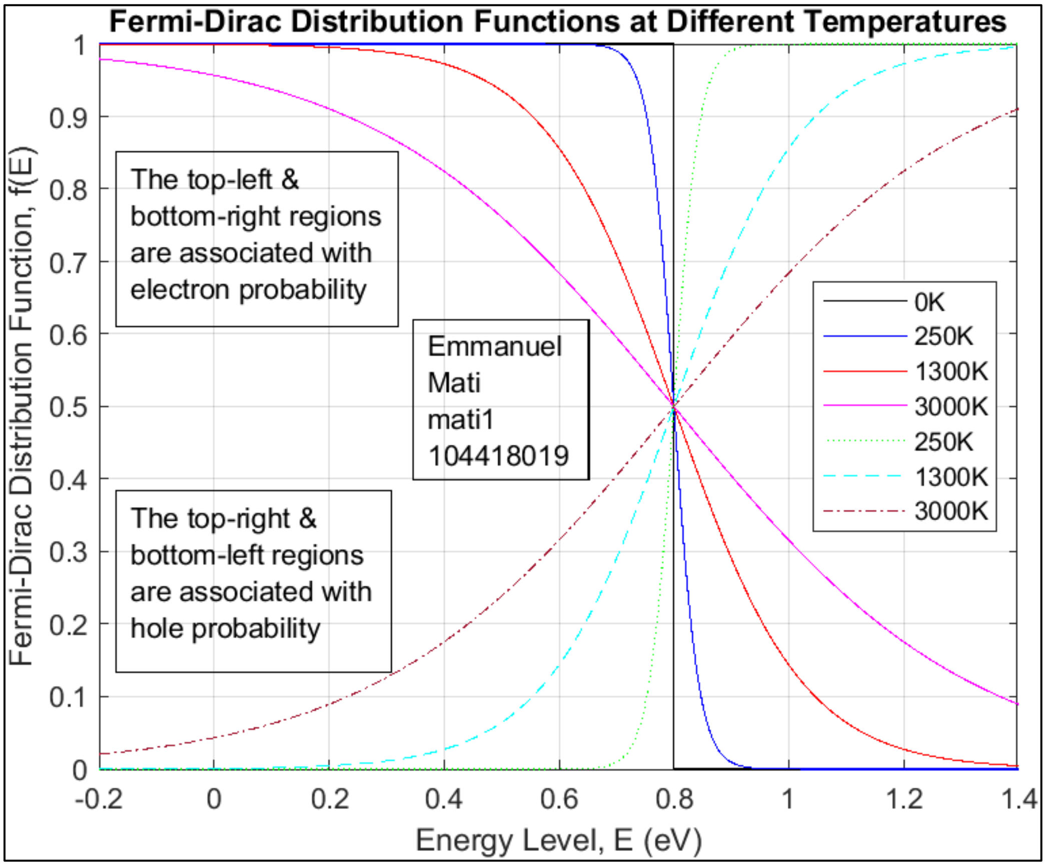


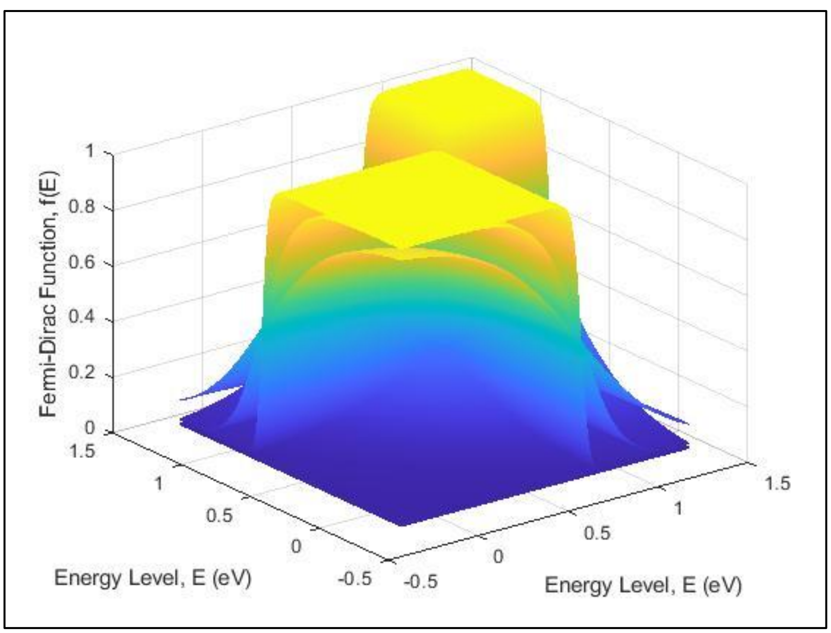


Q 3: Incorporates pt. 4 by using a wide range, pt. 6's hole concentrations, and pt. 8/9 labelling

E(f) = 0.80

Temps: 250k, 1300k, 3000k





Discussion:

Q5.

Throughout the entire experiment, the electron concentrations were lower at higher temperatures when the Fermi Energy Ef, was greater than the energy level E (Ef > E). As the Fermi level increased, the probability that an energy state at a higher energy level E was occupied by an electron also increased. Interestingly enough, when The Fermi Level became smaller than the energy level (E > Ef) the electron concentrations were greater at high temperatures. When the energy level equalled the Fermi level (E = Ef) the electron concentrations at every temperature were the same. Hence, we can say that when the temperature increases, there are higher electron concentrations when E > Ef and a lower concentration when Ef > E.

Q7.

As temperatures increased or decreased, hole concentrations had the opposite effect that electron concentrations had. At higher temperatures, the hole concentrations were higher when the Fermi-Energy level was greater than the Energy level (Ef > E). When the Fermi Energy was equal to the energy level (Ef = E), the hole and energy concentrations were equal. Lastly, when energy levels were higher than the Fermi level (E > Ef), the higher temperatures had lower hole concentrations.

Throughout this lab, the relationship between electron concentrations and hole concentrations at various temperatures has shown that they are inversely related. Moreover, it is shown that electron concentrations at lower Fermi-levels and higher temperatures tend to be higher when E > Ef and lower when E < Ef. The opposite can be said about hole concentrations. Unique to both hole and electron concentrations is that when E = Ef, the concentrations are equal to each other no matter the temperature. The only effect that the Fermi level has, was changing how each temperature behaved by either delaying or increasing the amount of energy, E, needed before the Fermi level was passed. This did not affect the behaviour stated previously. To better visualize these findings, please see table 1 below.

Let:

F(E)1 = electron concentration at 250 K

F(E)2 = electron concentration at 1200 K

Table 1 Hole and Electron Concentrations

	E < Ef	**E = Ef**	**E > Ef**
Electron Concentration	F(E)1 > F(E)2	F(E)1 = F(E)2	F(E)1 < F(E)2
Hole Concentration	1-F(E)1 < 1-F(E)2	1-F(E)1 =1- F(E)2	1-F(E)1 > 1-F(E)2