The Fermi-Dirac distribution function
by Dr. Colton, Physics 581 (last updated: Fall 2020)

\[ f(\varepsilon, \tau) = \frac{1}{e^{(\varepsilon - \mu)/\tau} + 1} \]

I will plot this for increasing temperatures, using \( \mu = 1 \) in some units (e.g. possibly in electron volts) and with energy \( \varepsilon \) as the x-axis.

- \( \tau = 0.001 \)
- \( \tau = 0.02 \)
- \( \tau = 0.1 \)
- \( \tau = 0.3 \)
For the next plots the temperature is super hot! Our assumption breaks down: $\mu$ cannot still equal 1 for these plots. It actually shifts to the left, and becomes negative at some point.

\[\tau = 1\]  
\[\tau = 100\]

Kittel Fig. 6.3 (pg. 136) shows what the Fermi-Dirac distribution function really looks like at high temperatures, using actual units and incorporating in the aforementioned shift of $\mu$ with temperature, in a material where $\mu$ is initially (low temperatures) equal to 4.309 eV (so that $\mu/k = 50000$ K):

The chemical potential $\mu$ can be read off the graph for each temperature as the energy at which $f$ equals 0.5.