ABACUS Exercise: Carriers Distribution vs. Energy

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Objective: The objective of this problem is to teach the students how the occupancy function changes with temperature, therefore affecting the population of available energy states in the conduction and valence bands.

Problem Specification: An effective density of states in the conduction band of silicon is equal to $2.8 \times 10^{19} \, cm^{-3}$ (at room temperature). The density of states effective mass for silicon is $1.182 m_e$ at 300 K and $1.077 m_e$ at 77 K, where m_e is the free electron rest mass. Consider a sample doped at $10^{16} \, cm^{-3}$ by shallow ionized donors. Find an expression for the number of electrons per unit energy, dn / dE, in the conduction band as a function of energy in this sample and plot it at T=77 K and T=300 K.

Literature: If you need help for solving this problem, please use one of the following two texts:

- Robert F. Pierret, *Semiconductor Device Fundamentals* (Addison-Wesley Publishing Company, 2006).

- Michael Shur, *Physics of Semiconductor Devices* (Prentice Hall, 1990).