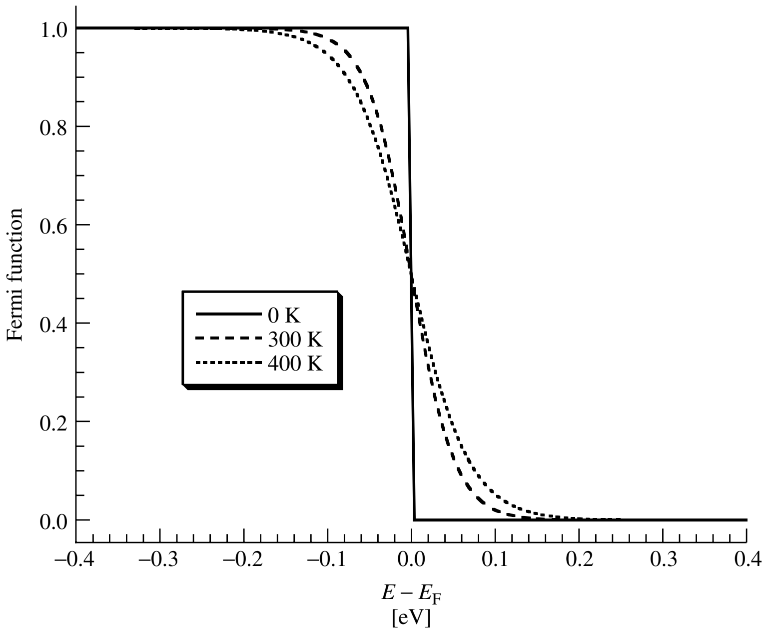

Figure 3.4 The Fermi function at various temperatures

and

$$N_V = 2\left(\frac{2\pi m_p^* kT}{h^2}\right)^{3/2}. \tag{3.14}$$

When the Fermi energy, E_F, is sufficiently far (>3 kT) from either bandedge, the carrier concentrations can be approximated (to within 2%) as [7]

$$n_o = N_C e^{(E_F - E_C)/kT} \tag{3.15}$$

and

$$p_o = N_V e^{(E_V - E_F)/kT} \tag{3.16}$$

and the semiconductor is said to be *nondegenerate*. In nondegenerate semiconductors, the product of the equilibrium electron and hole concentrations is independent of the location of the Fermi energy and is just

$$p_o n_o = n_i^2 = N_C N_V e^{(E_V - E_C)/kT} = N_C N_V e^{-E_G/kT}. \tag{3.17}$$

In an undoped (intrinsic) semiconductor in thermal equilibrium, the number of electrons in the conduction band and the number of holes in the valence band are equal; $n_o = p_o = n_i$, where n_i is the intrinsic carrier concentration. The intrinsic carrier concentration can be computed from (3.17), giving

$$n_i = \sqrt{N_C N_V} e^{(E_V - E_C)/2kT} = \sqrt{N_C N_V} e^{-E_G/2kT}. \tag{3.18}$$