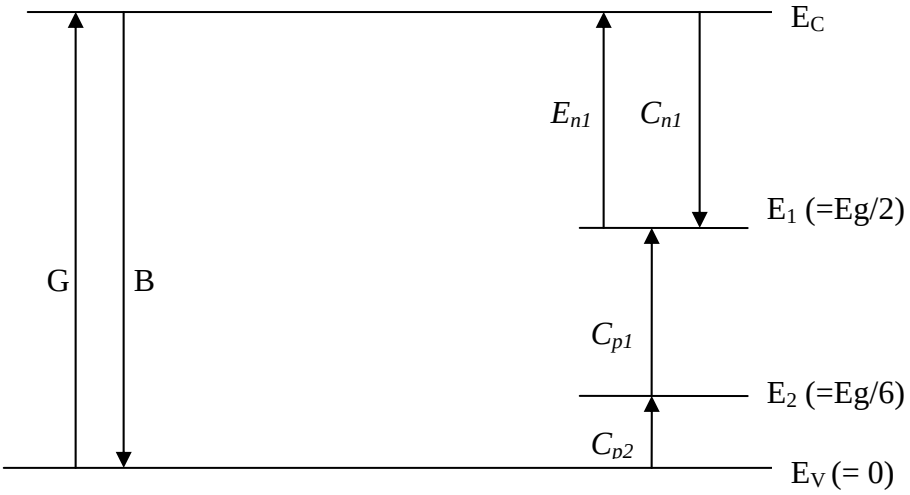
**ECE6453 (Spring 2008)**
**Homework 2**
Due Date: January 31, 2008 (Thursday)
Note: No late homework will be accepted

1. In calculating the density-of-state effective mass, we use the following equations:

   $m_{de}^* = M_C(m_1^* m_2^* m_3^*)$ , where $M_C$ is the number of band-minimum equivalency. The values of $M_C$ are 6 for silicon, 1 for GaAs, and 4 for Ge, respectively. Explain how you may find these numbers. What is the value of $M_C$ for $Al_xGa_{1-x}As$ if $x$ = 0.6? (Hint: observe band structure symmetry using extended zone scheme)

2. The photogeneration process provides a way to convert photon energy into electric energy. A lightly doped bulk *n*-GaAs sample ($n = 10^{10}$ cm$^{-3}$) is optically excited such that an induced open-circuit voltage of 0.259 V is produced. The relaxation times within the sample are given as $\tau_n = \tau_p = 1.0 \times 10^{-8}$ s. Assume that the $n_i = 1.79 \times 10^6$ cm$^{-3}$ and kT = 0.0259 V, determine the excess electron and hole concentration due to the light illumination. (Hint: quasi-fermi level)

3. Consider a system with two types of deep-level traps as shown below. Assume that the # of traps of type 1 are $N_1$ and of type 2 are $N_2$. The interband recombination rate is $B$ and the interband generation rate is $G$. The only processes involving the traps are shown in the graph as well. Define $E_1$ as the energy of traps 1 and $E_2$ as the energy of traps 2. Write the rate equations for electrons in the conduction band and in the two types of traps under steady state.

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4. Discuss the effects of piezoelectric scattering and impurity scattering on the electron mobility for silicon at T = 100 K.