UNIVERSITY OF CALIFORNIA, BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE 130/230M — Spring 2013
Integrated Circuit Devices — Prof. Liu & Dr. Xu

QUIZ #1
Time allotted: 25 minutes

NAME: _____ _____ _____
(print) Last First Signature

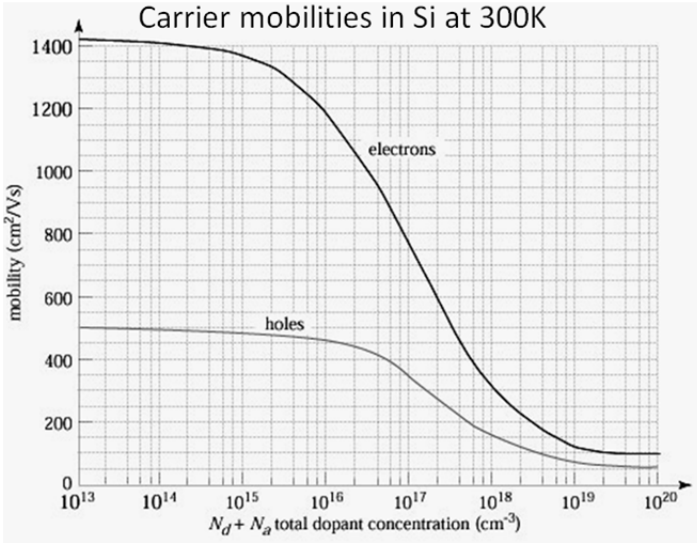
STUDENT ID#: _____

INSTRUCTIONS:

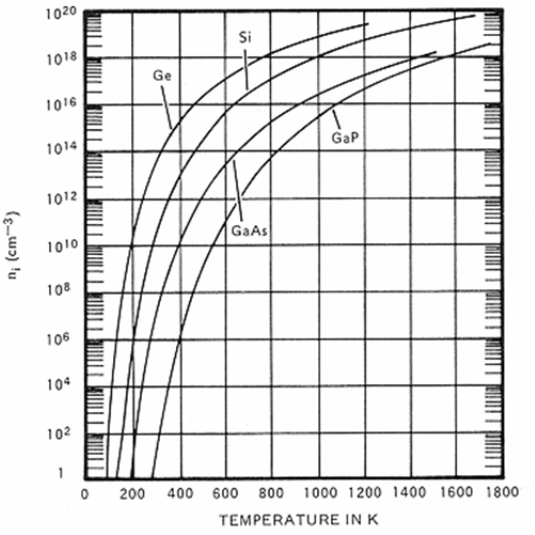
1. **SHOW YOUR WORK, and write legibly!**
2. **Underline or box numerical answers, and specify units where appropriate.**

Properties of silicon (Si) at 300K

Description	**Symbol**	**Value**
Energy band gap	E_G	1.12 eV
Intrinsic carrier concentration	n_i	10^{10} cm^{-3}



Intrinsic Carrier Concentration *vs.* Temperature

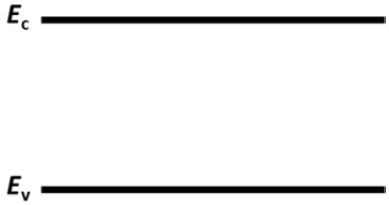


Problem 1 [8 points]

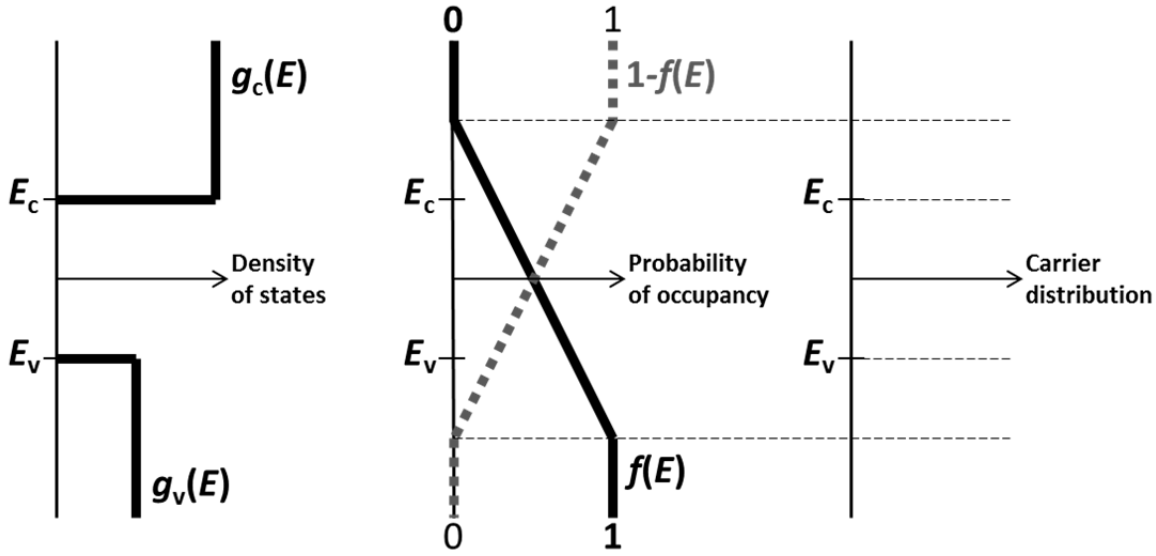
a) Why is it important to keep track of crystallographic planes and directions within a Si crystal? [2 pts]

b) Does the conductivity of undoped Si vary significantly with temperature near 300K? Briefly explain your answer. [3 pts]

c) Illustrate thermal generation and donor atom ionization on the energy band diagram [3 pts]

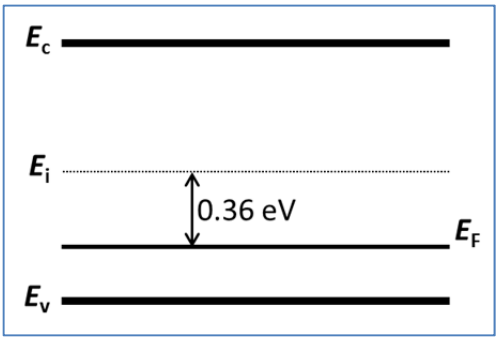


Problem 2 [6 points]
Sketch the electron and hole distributions within the conduction and valence bands, respectively, for a semiconductor with the given density of states and occupancy functions [4 pts]



Is this material n-type or p-type? Justify your answer. [2 pts]

Problem 3 [11 points]
The energy band diagram for a uniformly doped Si sample maintained at T=300K is shown below.
a) Is this sample n-type or p-type? [1 pt]



b) What are the carrier concentrations (n and p)? [4 pts]
(Remember that $kT \cdot ln(10) = 0.060$ eV at 300K)

c) Roughly estimate the resistivity of this sample. [4 pts]

d) Estimate the temperature at which this sample becomes intrinsic. [2 pts]