NAME:_____   **PUID: :**_____

ECE 305 Exam 1: Spring 2015
January 30, 2015
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This is a closed book exam. You may use a calculator and the formula sheet at the end of this exam. Following the ECE policy, the calculator **must** be a Texas Instruments TI-30X IIS scientific calculator.

There are three equally weighted questions. To receive full credit, you must **show your work** (scratch paper is attached).

The exam is designed to be taken in 50 minutes.

Be sure to fill in your name and Purdue student ID at the top of the page.

DO NOT open the exam until told to do so, and stop working immediately when time is called.

The last page is an equation sheet, which you may remove, if you want.

75 points possible, 10 per question

1) 25 points (5 point per part)

2) 25 points (2a (10 points) 2b (10 points) 2c (5 points))

3) 25 points (3a (10 points) 3b (10 points) 3c (5 points))

------------------------ Course policy ------------------------

I understand that if I am caught cheating in this course, I will earn an F for the course and be reported to the Dean of Students.

Read and understood: _____
   signature

Answer the **five multiple choice questions** below by **drawing a circle** around the **one, best answer**.

1a)   In GaAs, how many of the nearest neighbors of an arsenic (As) atom are Ga atoms?
       a) 1
       b) 2
       c) 3
       d) 4
       e) 5

1b)   Which of the following is true about the unit cell of a crystal?
       a) It can be used to reproduce the entire crystal.
       b) It contains one atom.
       c) It is unique.
       d) Both a) and b).
       e) Both b) and c).

1c)   What is the probability that a state with energy $E = E_F$ is occupied?
       a) 0.0
       b) 0.5
       c) 1.0
       d) << 1
       e) >> 1

1d)   Which plane is perpendicular to a $\left[1\bar{1}0\right]$ direction?
       a) $\left(001\right)$
       b) $\left(\bar{1}01\right)$
       c) $\left(01\bar{1}\right)$
       d) $\left(0\bar{1}1\right)$
       e) $\left(1\bar{1}0\right)$

1e)   As temperature increases from 0 K to high temperature, the carrier concentration
       goes through three regions. In what order does the transition occur?
       a) intrinsic, extrinsic, freezeout
       b) extrinsic, intrinsic, freezeout
       c) freezeout, intrinsic, extrinsic
       d) freezeout, extrinsic, intrinsic
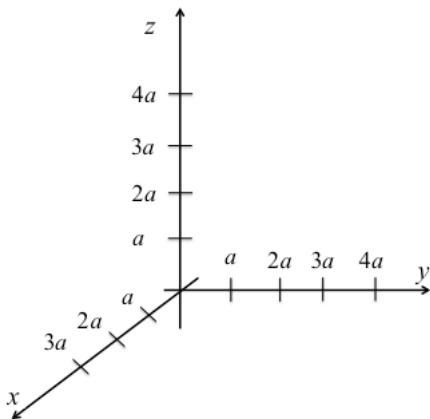   e) intrinsic, freezeout, extrinsic

2a) Deduce the Miller indices for the plane shown below. **Show your work and draw a box around your answer.**
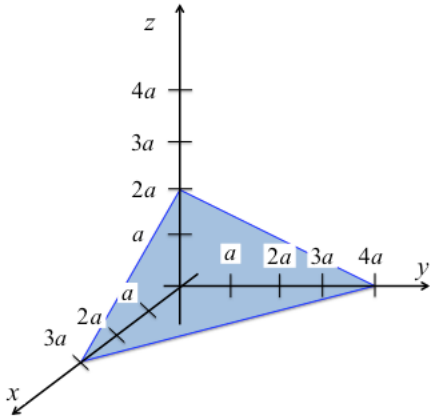
2b) Draw (6 4 3). **Show your work.**
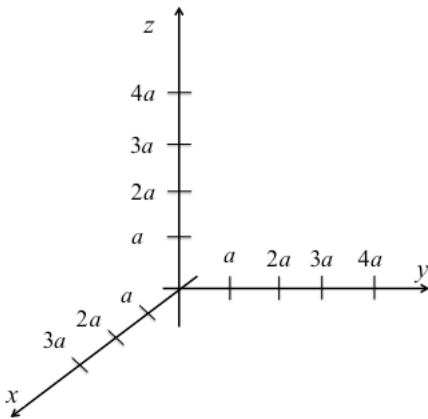
2c) Draw [3 4 0]. **Show your work.**

3) An n-doped silicon sample is in equilibrium at T = 700 K. It has an electron concentration of $n = 7.148 \times 10^{16}$ cm^{-3} and an intrinsic carrier concentration of $n_i = 2.865 \times 10^{16}$ cm^{-3}. Answer the following questions.

3a) What is the concentration of holes?

3b) What is the concentration of donors, N_D? (You may assume that $N_A = 0$ and that the donors are fully ionized.)

3c) Where is the Fermi level located with respect to the intrinsic level? (A numerical answer is required).

SCRATCH PAPER