NAME:_____ **PUID: :**_____

ECE 305 Exam 1: Fall 2014
September 5, 2014
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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.

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.

30 points possible, 10 per question

1) 2 points per part – 10 points total

2) 10 points

3) 10points

---------- Exam Integrity Statement ----------

I certify that I have neither given nor received unauthorized aid on this exam. ☐

Write out the above statement:

Signature: _____

Answer the **five multiple choice questions** below by choosing the **one, best answer**.

1) How many valence electrons does arsenic (As) have?
   a) 2
   b) 3
   c) 4
   d) 5
   e) 6

2) Which of the following is true about polycrystalline silicon?
   a) Each atom occupies a site of a single, crystal lattice
   b) Each atom in a part of the material (grain) occupies a site in te crystal lattice of that grain
   c) Each atom occupies a random location
   d) It contains no defects
   e) Each atom occupies sites on two different crystal latttices

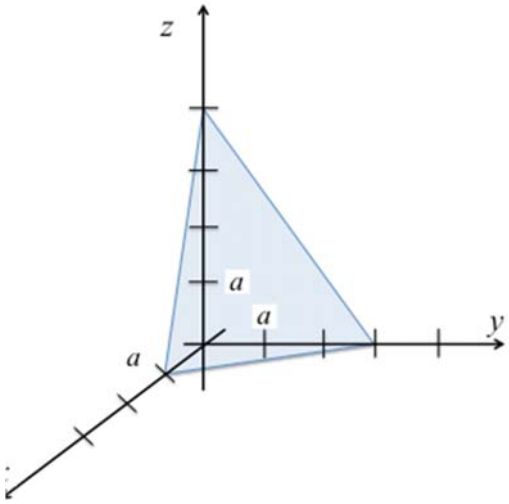
3) What is the difference between a semiconductor and an insulator?
   a) Insulators are polycrystalline and semiconductors are crystalline
   b) Insulators are crystalline and semiconductors are polycrystalline
   c) Insulators have a diamond lattice and semiconductors have a zincblende lattice
   d) Insulators have a smaller bandap than semiconductors
   e) Insulators have a larger bandgap than semiconductors

4) Which plane is perpendicular to a <100> direction?
   a) (001)
   b) (010)
   c) (100)
   d) (011)
   e) (101)

5) At T = 0 K, what is the density of holes in the valence band of a pure semiconductor?
   a) the atomic density of the material.
   b) Avagrodro's number.
   c) The density of dopants.
   d) The packing fraction of the material.
   e) Zero

2) What is the packing fraction of a aluminum. (Face center cubic, lattice spacing $a = 0.405\ \text{nm}$.) **Show your work and draw a box around your answer.**

3) Deduce the Miller indices for the plane shown below. **Show your work and draw a box around your answer**



SCRATCH PAPER

ECE-305: Key Equations

Fall 2014

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Physical constants:

$\hbar = 1.055 \times 10^{-34}$ [J-s]
$m_0 = 9.109 \times 10^{-31}$ [kg]
$k_B = 1.380 \times 10^{-23}$ [J/K]
$q = 1.602 \times 10^{-19}$ [C]

Miller Indices: (hkl) {hkl} [hkl] <hkl>

Angle between two planes: $\cos\theta = \dfrac{h_1 h_2 + k_1 k_2 + l_1 l_2}{\sqrt{h_1^2 + k_1^2 + l_1^2}\sqrt{h_2^2 + k_2^2 + l_2^2}}$

Spacing between two planes: $d = \dfrac{1}{\left|\vec{N}\right|} = \dfrac{a}{\sqrt{h^2 + k^2 + l^2}}$