ECE440 Quiz #0

(Popup Quiz #0 will **NOT** be counted for the course scoring, but will only be used (1) for students’ background survey and (2) to partially determine students’ prerequisite eligibility to enroll the course in case no prerequisite courses have been taken.)

1. **Fundamentals of semiconductors.**

   (1) Please fill in the table below to show the crystal structure and basic physical parameters of the common semiconductors.

<table>
<thead>
<tr>
<th>Crystal Structure</th>
<th>Si</th>
<th>Ge</th>
<th>GaAs</th>
<th>GaN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandgap at 300K (eV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   (2) Please describe briefly what is the difference among insulators, conductors, and semiconductors in the point of view of band structure?

2. **Electronic Configuration.**

   Please write the electronic configuration of Ca (20 electrons), Ti (22 electrons), V (23 electrons), Ni (28 electrons), and Zn (30 electrons). An example of electronic configuration of Ar is given below \( [\text{Ar}] = 1s^22s^22p^63s^23p^6 \).

   Ca: ______________________________________________________
   Ti: _____________________________________________________
   V: _____________________________________________________
   Ni: ____________________________________________________
   Zn: ____________________________________________________
3. **Semiconductor carrier statistics.**

   (1) Please write down carrier density equations in non-degenerate semiconductors, which are ones of the most important equations in semiconductor physics and devices.

   \[
   \begin{align*}
   n &= N_c \cdot \\
   p &= N_v \cdot \\
   n &= n_i \cdot \\
   p &= p_i \cdot 
   \end{align*}
   \]

   (2) Consider Si doped with $10^{16}$ cm$^{-3}$ boron atoms (acceptors). (i) Calculate the carrier concentration ($n$ and $p$) at 300 K. (ii) Determine the position of the Fermi level and plot the band diagram. [\(\ln(10) \approx 2.3; \ k_B T \approx 26 \text{ meV at 300K}; \text{ The intrinsic carrier concentration of Si is } 10^{10}\text{ cm}^{-3}.\)]