1 Hour Closed book, no notes, no calculators. Covers the material in the first 2 weeks of class: Semiconductors, PN Junctions, Forward and reverse bias, LED, Schottky, Zener, and Varactor diodes.

Page 1, ten questions, one point each.

1. Write the name of an element that might be used to dope Silicon that would serve as a donor.

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2. An element with \( n_i \sim 10^6 \text{/cm}^3 \) is an insulator, a conductor or semiconductor? (circle one)

3. Silicon doped with \( N_A \sim 10^{14} \text{/cm}^3 \) is lightly doped p, heavily doped p, lightly doped n or heavily doped n? (circle one)

4. Write the expression for the Capacitance of a parallel plate capacitor here:

\[
C = \frac{\varepsilon s}{q} \left( \frac{1}{N_A} + \frac{1}{N_D} \right) \phi_j
\]

5. A pn junction is heavily doped with Ga and lightly doped with P. Is the depletion zone expected to be wider in the p or n side? (circle one)

6. True or False  Blue LEDs are built in SiC because of the wider band gap and direct band gap. (circle one)

7. True or False  Capacitance increases as reverse bias voltage is increased across a PN junction.

8. True or False  Heavily doped PN junctions have more capacitance than lightly doped PN junctions at zero bias.

9. \( V_t \sim \space{\text{mV}} \) at room temperature

10. Write an expression for \( V_t \) in terms of fundamental quantities, with units:
A diode conducts 4 mA with a forward voltage drop of 680 mV. Write an expression that shows the relationship between diode forward voltage drop and diode current. From this expression and considering only $V_t$, what do you expect to happen as temperature increases? Estimate the forward voltage drop if the current decreases to 1 mA, and explain your estimate. (Re-read the question after you have finished and make sure you have answered each part.)

From the expressions for a parallel plate capacitor and the formulas for built-in potential and depletion width at zero bias, discuss how PN capacitance might change as temperature increases from cool room temperature to 140F. Consider just $V_t$ first, and then include $n_i$. Do you expect capacitance to increase or decrease, by a little bit or a large change?