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**Week 8 Quiz ANSWERS: Deviations from Ideal and Small Signal Model**

**ECE 305: Semiconductor Devices**

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

- 1) Which of the following is true about “impact ionization”?
  - a) It is the cause of avalanche breakdown.
  - b) It can be initiated by either electrons or holes.
  - c) It generates both electrons and holes.
  - d) All of the above.**
  - e) None of the above.
  
- 2) What effect does quantum mechanical tunneling have on a PN junction?
  - a) It can lead to reverse breakdown at low voltages ( $-5 < V < 0$ ).**
  - b) It can lead to reverse breakdown at high voltages ( $V < -15$ ).
  - c) It can lead to current “roll-off” at high voltages.
  - d) It can increase the series resistance of a diode.
  - e) It is the most common cause for  $n = 2$  currents at low forward bias.
  
- 3) Why does the reverse bias current increase as the square root of voltage in a Si diode?
  - a) Because of quantum mechanical tunneling.
  - b) Because of impact ionization.
  - c) Because of recombination in the transition region.
  - d) Because of generation in the transition region.**
  - e) Because of series resistance.
  
- 4) What is the primary reason for the strong temperature dependence of the forward biased current in an N+P junction?
  - a) The  $D_n$  term in  $J_0$ .
  - b) The  $L_n$  term in  $J_0$ .
  - c) The  $N_A$  term in  $J_0$ .
  - d) The  $n_i^2$  term in  $J_0$ .**
  - e) None of the above

- 5) Which of the following is true about the small signal model of a PN junction?
- It consists of a resistor in series with a capacitor.
  - It consists of a resistor in parallel with a capacitor.**
  - It consists of a resistor in series with an inductor.
  - It consists of a resistor in parallel with an inductor.
  - It consists of a resistor in parallel with a capacitor in parallel with an inductor.
- 6) Which of the following is true about the resistor in the small signal model of a diode?
- It has a very large value in reverse bias and a very small value in forward bias.
  - It is equal to  $(dI_D/dV_A)^{-1}$ .
  - In forward bias, it is very close to  $(k_B T/q)/I_D$ .
  - All of the above.**
  - None of the above.
- 7) Which of the following is true of the junction capacitance?
- It is proportional to  $1/\sqrt{V_{bi} - V_A}$ .**
  - It is proportional to  $\sqrt{V_{bi} - V_A}$ .
  - It is proportional to  $1/(V_{bi} - V_A)$ .
  - It is proportional to  $(V_{bi} - V_A)$ .
  - It is proportional to  $\exp(qV_A/k_B T)$ .
- 8) Which of the following is true of the diffusion capacitance?
- It is proportional to  $1/\sqrt{V_{bi} - V_A}$ .
  - It is proportional to  $\sqrt{V_{bi} - V_A}$ .
  - It is proportional to  $1/(V_{bi} - V_A)$ .
  - It is proportional to  $(V_{bi} - V_A)$ .
  - It is proportional to  $\exp(qV_A/k_B T)$ .**
- 9) What is  $\Delta n = (n_i^2/N_A)(e^{qV_A/k_B T} - 1)$  called?
- The Einstein relation .
  - The Caughey-Thomas relation.
  - The second law of thermodynamics.
  - Moore's Law
  - The Law of the Junction.**