Diode Content and Equations

Diode Symbol, Terminal Names, Voltage and Current Orientations

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Ideal Diode:		**Model**
FB:	$v_D = 0$, for $i_D > 0$	Short
RB:	$i_D = 0$, for $v_D < 0$	Open

Junction Diode: $i_D = I_S(\exp(v_D/nV_T) - 1)$, for both FB and RB

Range of values for I_S (1×10^{-8} to 1×10^{-15}[Amps]) and n (1 to 2).
V_T is dependent on temperature (Typically 0.025V)

FB approximation ($v_D >> nV_T$): $i_D = I_S\exp(v_D/nV_T)$
RB approximation ($v_D << -nV_T$): $i_D = -I_S$

0.7V CVD Model:		**RB: Open or FB: 0.7V Battery**
FB:	$v_D = 0.7V$, for $i_D > 0$	Short in series with 0.7V Battery (ideal diode is FB)
RB:	$i_D = 0$, for $v_D < 0.7V$	Open in series with 0.7V Battery (ideal diode is RB, $v_{DI} < 0$)

PWL Model:		**RB: Open or FB: Resistor and Battery**
FB:	$i_D = (v_D - V_{D0})/r_D$, for $v_D > V_{D0}$	Short in series with Resistor and Battery
RB:	$i_D = 0$, for $v_D < V_{D0}$	Open in series with Resistor and Battery

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Small Signal Diode Model: $r_d = nV_T/I_D$
always assume the diode is FB for small signal analysis problems

Small Signal resistance given i(v) $r = 1/i'_D(v_D)$ evaluated at (V_D, I_D)
Know the table of devices and their Large Signal Model and Small Signal Model

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Zener Diode (CVD Model): **Ideal Diode in series with a Battery**

BD: $v_Z = V_Z$, for $i_Z > 0$ Short in series with a Battery (ideal diode is FB)

RB: $i_Z = 0$, for $v_Z < V_Z$ Open in series with a Battery (ideal diode is RB, $v_{DI} < 0$)

Zener Diode (PWL Model): **Ideal Diode in series with Resistor and Battery**

BD: $i_Z = (v_Z - V_{Z0})/r_z$, for $v_Z > V_{Z0}$ Short in series with Resistor & Battery (ideal diode is FB)

RB: $i_Z = 0$, for $v_Z < V_{Z0}$ Open in series w/ Res. & Battery (ideal diode is RB, $v_{DI} < 0$)

Zener Symbol and Voltage & Current Orientations

Difference and Similarities between Zener and Junction Diodes

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Diode Applications (what is the purpose, basic circuit and basic operation)

- Current Protection
- Simple Digital Logic
- **Limiter (Circuit Protection) – Transfer Functions**
- **Rectifier Circuits (v_{OUT}/v_{IN}, PIV)**
- **Regulator (line regulation, load regulation)**
- **AC/DC Supply (approximation for ripple voltage)**
- **Voltage Controlled Attenuator**
- Frequency Mixer

Semiconductors

- Silicon lattice (intrinsic, covalent bonds).
- Current (two types)
  - Drift – charge moving due to electric field.
  - Diffusion – charge moving due to heat and concentration gradient.
- Doped Silicon
  - N-Type: use Phosphorus to add extra electrons.
  - P-Type: use Boron to add extra holes.
  - Majority carriers
  - Minority carriers
  - Depleted
- PN Junction and Bias States (FB, RB, Breakdown)

Exam I Organization

Around 4-5 Problem Sections

Diode analysis at DC: Given a circuit, assume a bias, find the answer, & verify bias.

Diode Transfer Function: Given a circuit, assume a bias, find the transfer function, and find the range of the independent variable.

Diode Small Signal Analysis: Large Signal Circuit, Small Signal Resistance, Small Signal Relationship.

Short Answer Section: True or False, Calculations (maybe using exponential model), General Application Questions (line regulation, Peak Inverse Voltage, Ripple Voltage, …), AC/DC Supplies, Quick Analysis, Concept Understanding.

Semiconductor Examples:

HW8. (Concepts, not specific equations)

What are majority carriers in N-type silicon?

What direction does positive drift current flow in the PN junction?

When a P-Type silicon becomes depleted it will be positively charged. True or False.