

Section 21 PN Diode AC Response

Gerhard Klimeck

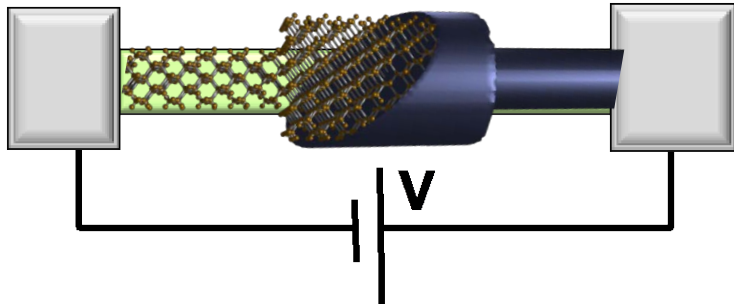
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School of Electrical and
Computer Engineering

Section 21

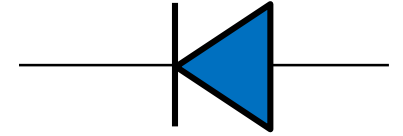
PN Diode AC Response




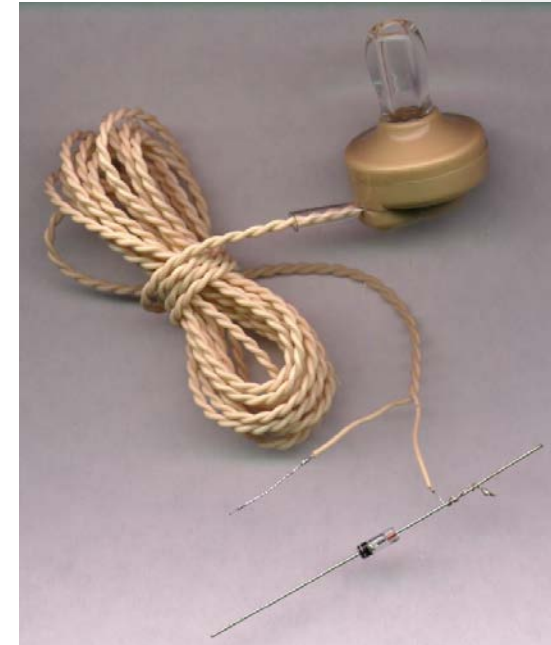
$$I = G \times V$$

$$= q \times n \times v \times A$$

↑ charge density ↑ ↑ velocity area

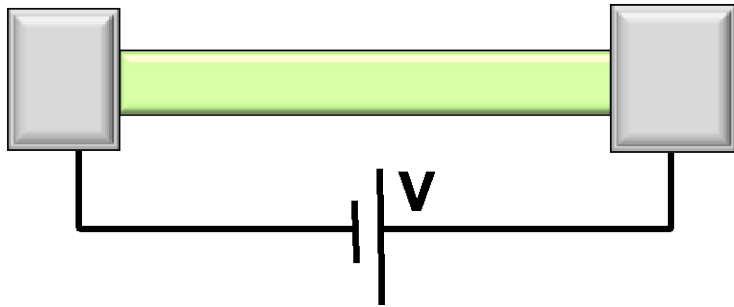


	Equilibrium	DC	Small signal	Large Signal	Circuits
PN Diode					
Schottky Diode	Diode in Non-Equilibrium (External DC+AC voltage applied)				
BJT/ HBT					
MOS					



Section 21

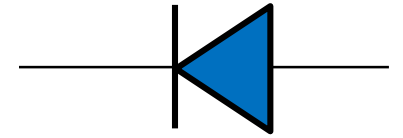
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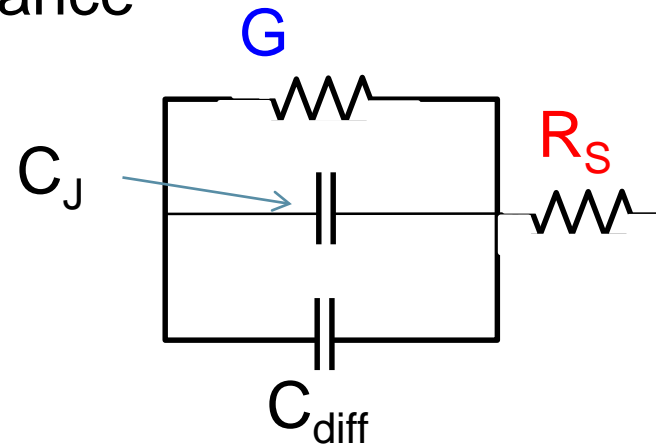
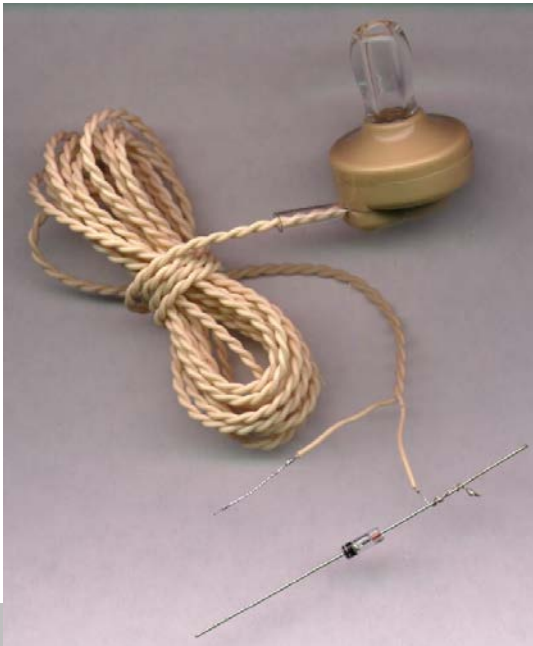
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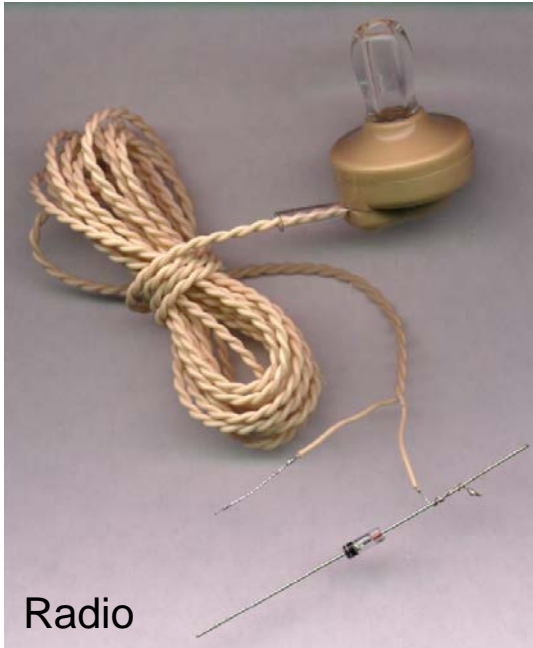


- > • 21.1 Conductance and series resistance
- > • 21.2 Majority carrier junction capacitance
- > • 21.3 Minority carrier diffusion capacitance

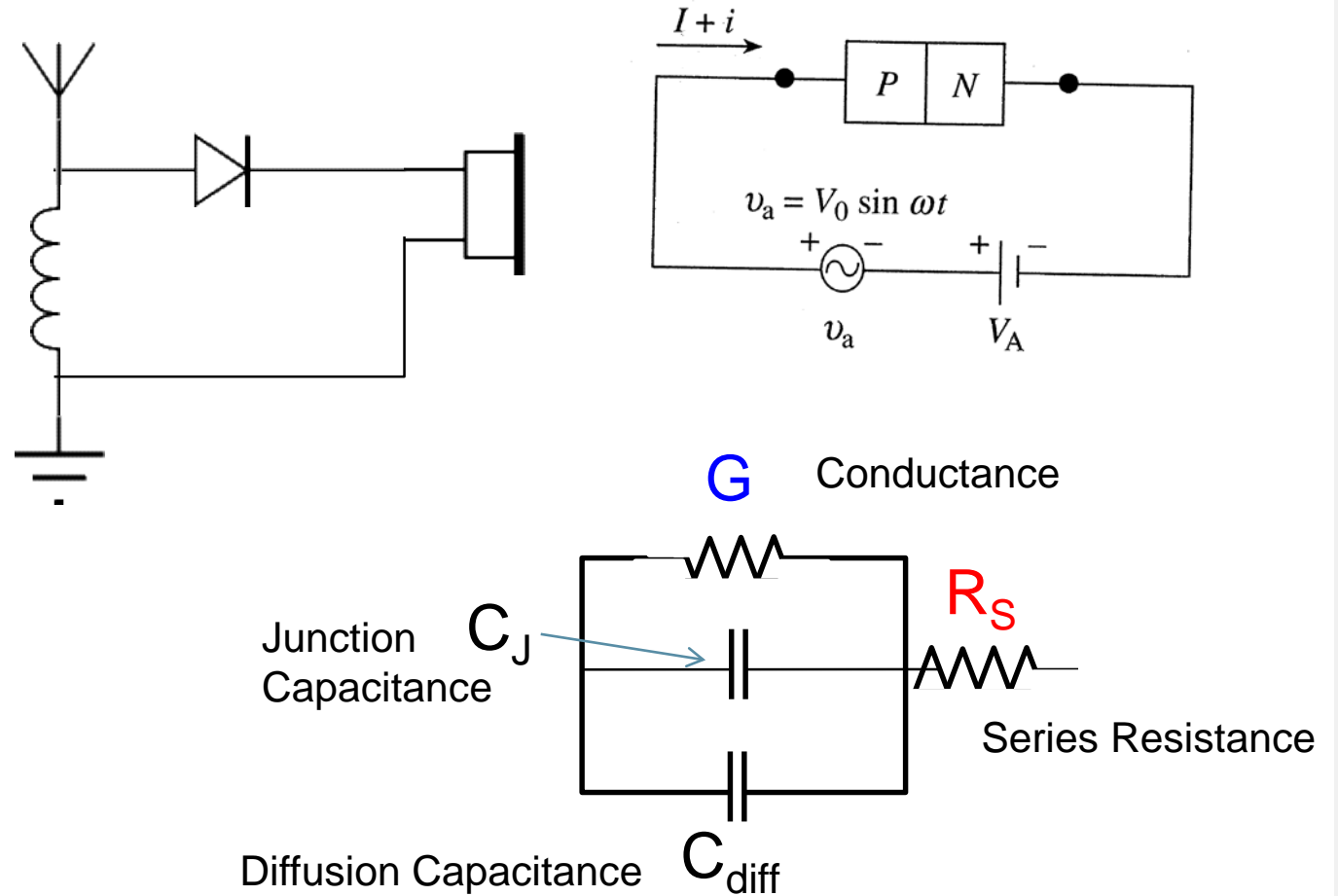


Why should we study AC Response?

Motivation



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Forward Bias Conductance

$$I = I_o \left(e^{q(V_A - R_S I)\beta / m} - 1 \right)$$

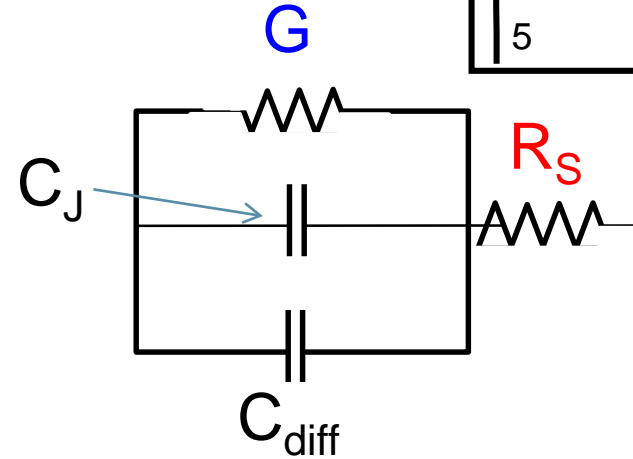
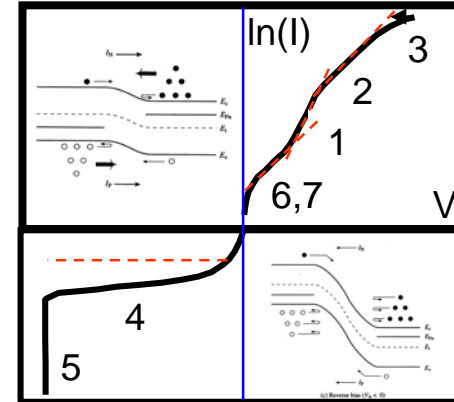
ln()

$m = \text{RG (2), diff (1), Ambipolar (2)}$

$$\ln \frac{I + I_o}{I_o} = q(V_A - R_S I) \frac{\beta}{m}$$

$$\frac{1}{I + I_o} \frac{d}{dI} = \left(\frac{dV_A}{dI} - R_S \right) \frac{q\beta}{m}$$

$$\frac{m}{q\beta(I + I_o)} = \frac{dV_A}{dI} - R_S$$



$$\frac{1}{g_{FB}} = R_S + \frac{m}{q\beta(I + I_o)}$$

Forward Bias Conductance

Reverse Bias Conductance

$$I = I_o \left(e^{q(V_A - R_S I) \beta / m} - 1 \right) - \frac{qn_i}{2\tau} B_0 \sqrt{V_{bi} - V_A}$$

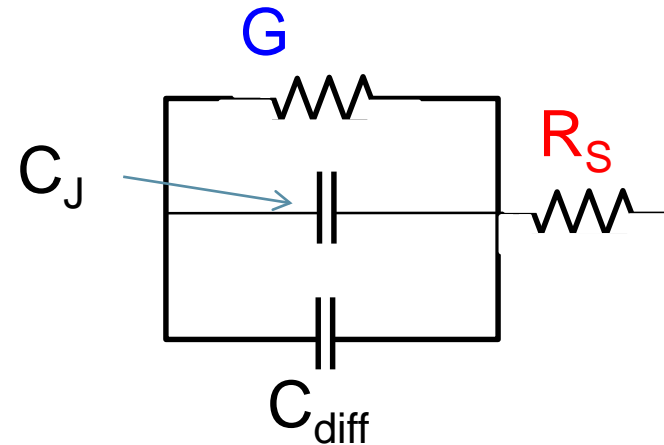
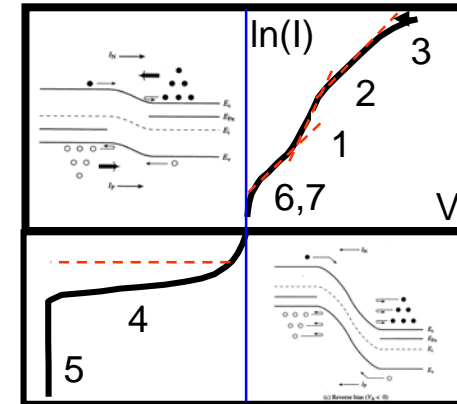
Recombination term

$$\approx -I_o - \frac{qn_i}{2\tau} B_0 \sqrt{V_{bi} - V_A}$$

$$\frac{d}{dV_A}$$

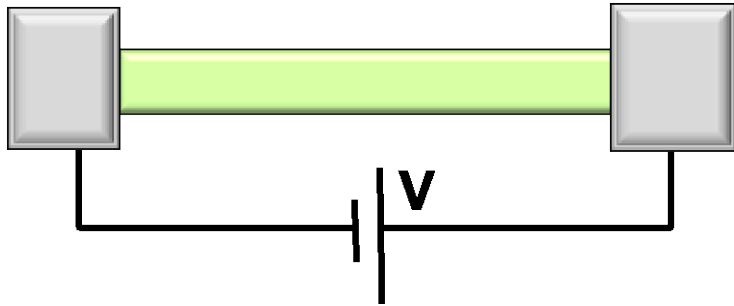
$$\frac{1}{g_{RB}} = \frac{qn_i B_0}{2\tau \sqrt{V_{bi} - V_A}}$$

Reverse Bias Conductance



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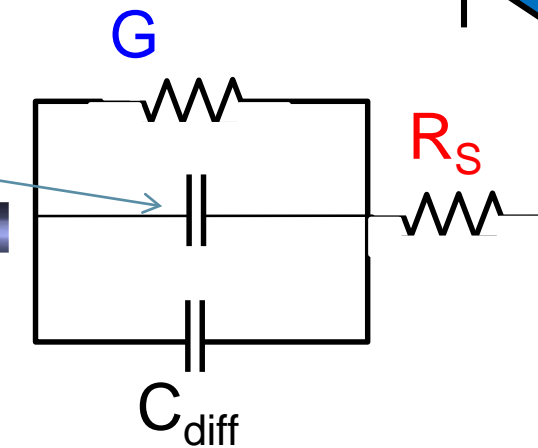
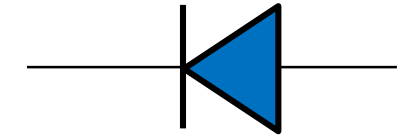
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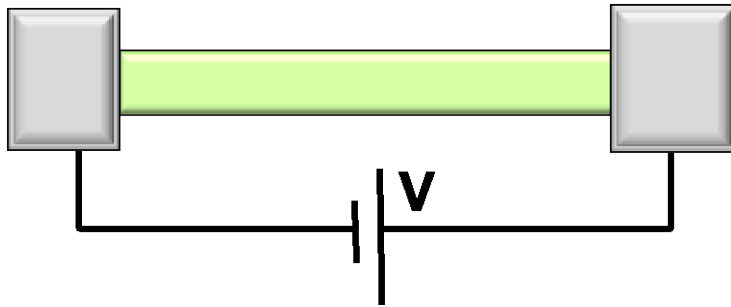


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$$\frac{1}{g_{FB}} = R_s + \frac{m}{q\beta(I + I_0)}$$

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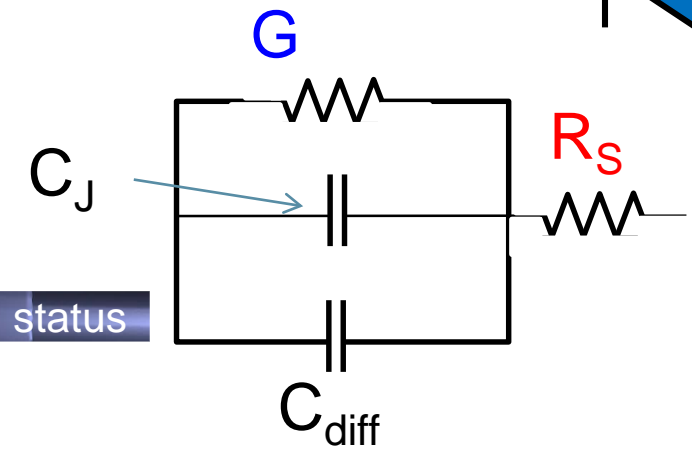
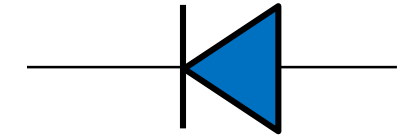
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