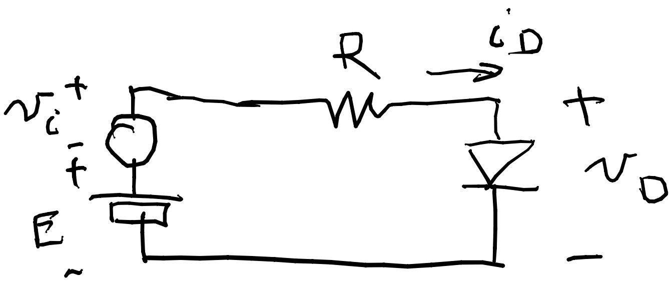
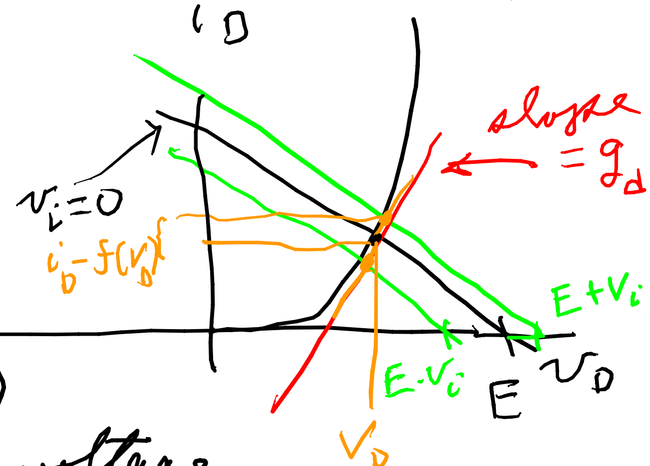
EE 303
02/01/06




$$i_D = f(v_D) \approx I_S(e^{v_D/V_T} - 1)$$

$V_T$ = thermal voltage
$= kT/|Q|$

$k$ = Boltzman's constant
$T$ = Temperature, °K
$|Q|$ = electron charge

$$i_D = f(V_D) + \frac{\partial f(V_D)}{\partial v_D}(v_D - V_D) + \frac{1}{2}\frac{\partial^2 f}{\partial v_d}\bigg|_{v_D = V_D}(v_d - V_D)^2 + \cdots$$

Taylor series

$$\approx f(V_D) + \frac{\partial f}{\partial v_D}\bigg|_{v_D = V_D}(v_D - V_D)$$

if $(v_d - V_D)^2$ is small enough = small signal

$$i_D - f(V_D) = i_D - I_D$$

by def. $f(V_D) \triangleq I_D$

$\triangleq i_d$ = (small) signal current

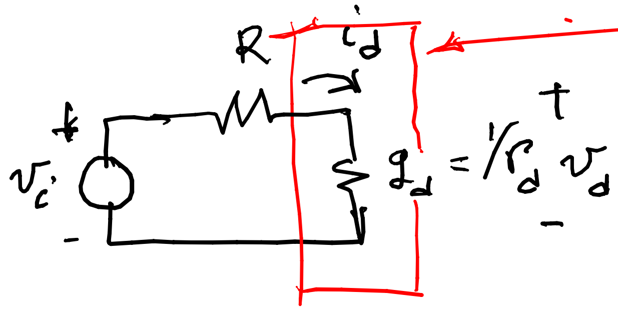
$v_D - V_D \triangleq v_d$ = (small) signal voltage

$$i_d = \frac{\partial f}{\partial v_D}\bigg|_{V_D} \cdot v_d$$

; diode conductance (at the Q point)

$$= \frac{\partial f}{\partial v_D}\bigg|_{V_D} = g_d$$

$i_d = g_d \cdot v_d$ (linear eq for small signal behavior)




equivalent circuit for the diode, valid for $|v_i| << E$

if $f(v_D) = i_D = I_S(e^{v_D/V_T} - 1)$

$$g_d = \left.\frac{\partial f}{\partial v_d}\right|_{v_d = V_D} = I_S \cdot \frac{1}{V_T} \cdot e^{v_D/V_T}\Big|_{v_D = V_D}$$

in active region $i_D \approx I_S e^{v_D/V_T}$

$$g_d \approx \frac{I_D}{V_T}$$ if in active region