

$$n(x) = N_c \exp\left(\frac{E_c(x) - E_f(x)}{kT}\right)$$

$$p(x) = N_v \exp\left(\frac{E_f(x) - E_v(x)}{kT}\right)$$

$$E_g = E_v(x) - E_c(x) = 1.11 \text{ eV (定数)}$$

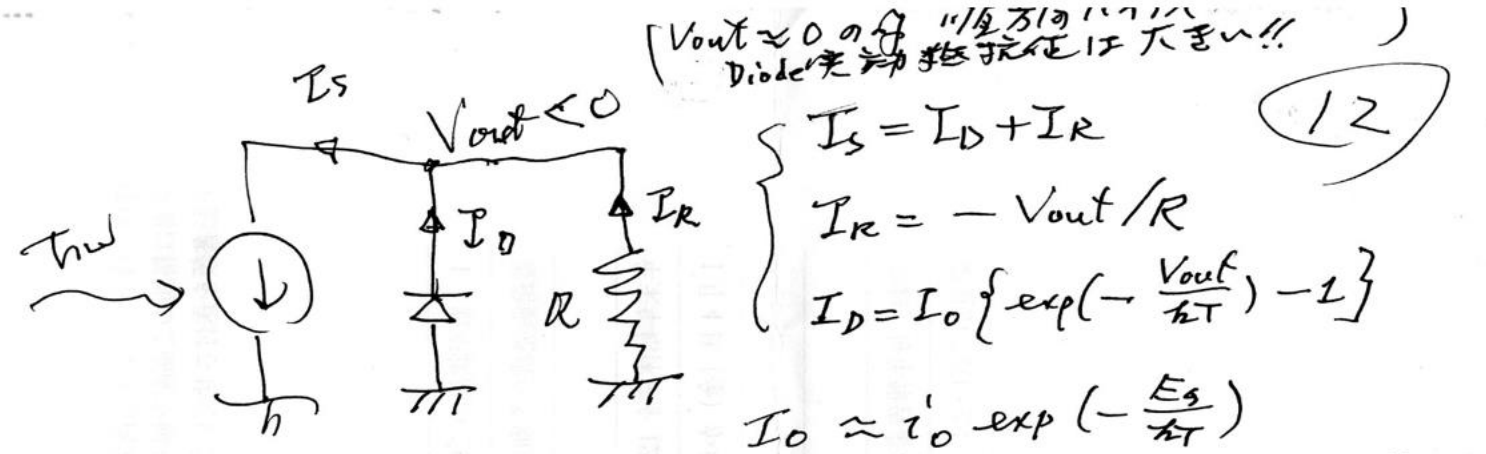
$$n(x)p(x) = N_c N_v \exp\left(\frac{E_c(x) - E_f(x)}{kT} + \frac{E_f(x) - E_v(x)}{kT}\right) = N_c N_v \exp\left(-\frac{E_g}{kT}\right) = n_i^2$$

$$I_R = I_0 \left( \exp\left(-\frac{V_{out}}{kT}\right) - 1 \right)$$

$$I_0 \approx i_0 \exp\left(-\frac{E_g}{kT}\right)$$

$$i_0 \approx e A n_i^2 \left[ \frac{D_e}{L_e N_A} + \frac{D_h}{L_h N_D} \right]$$

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$$I_S = I_D + I_R$$

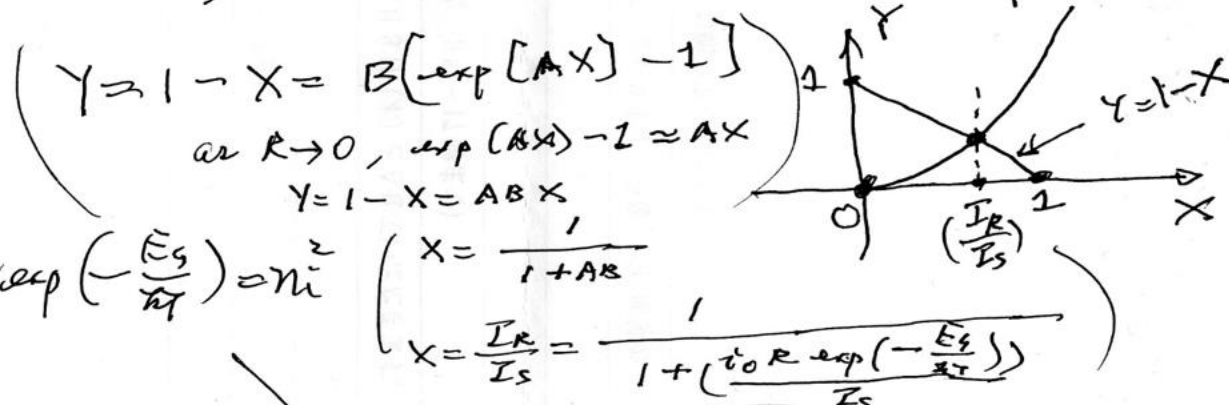
$$I_R = -V_{out} / R$$

$$I_D = I_0 \left\{ \exp\left(-\frac{V_{out}}{kT}\right) - 1 \right\}$$

$$I_0 \approx i_0 \exp\left(-\frac{E_g}{kT}\right)$$

$$\frac{I_D}{I_S} = 1 - \left(\frac{I_R}{I_S}\right) = \left\{ \frac{i_0 \exp\left(-\frac{E_g}{kT}\right)}{I_S} \right\} \left\{ \exp\left(\frac{R I_S}{kT} \frac{I_R}{I_S}\right) - 1 \right\}$$

$$X = \frac{I_R}{I_S} \quad A = \frac{R I_S}{kT} \quad B = \frac{i_0 \exp\left(-\frac{E_g}{kT}\right)}{I_S}$$



$$X = \frac{1}{1 + AB}$$

$$X = \frac{I_R}{I_S} = \frac{1}{1 + \left( \frac{i_0 R \exp\left(-\frac{E_g}{kT}\right)}{I_S} \right)}$$

or  $I_S \rightarrow \infty, X = 1$   
 (負抵抗  $R \rightarrow 0$ ) 力 ( $\frac{I_R}{I_S} \rightarrow 1$ )  
 力  $I_S \rightarrow \infty$  力 ( $\frac{I_R}{I_S} \rightarrow 1$ )  
 (11/11 方向 電流  $I_D$  力 11/11 11/11 11/11)

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