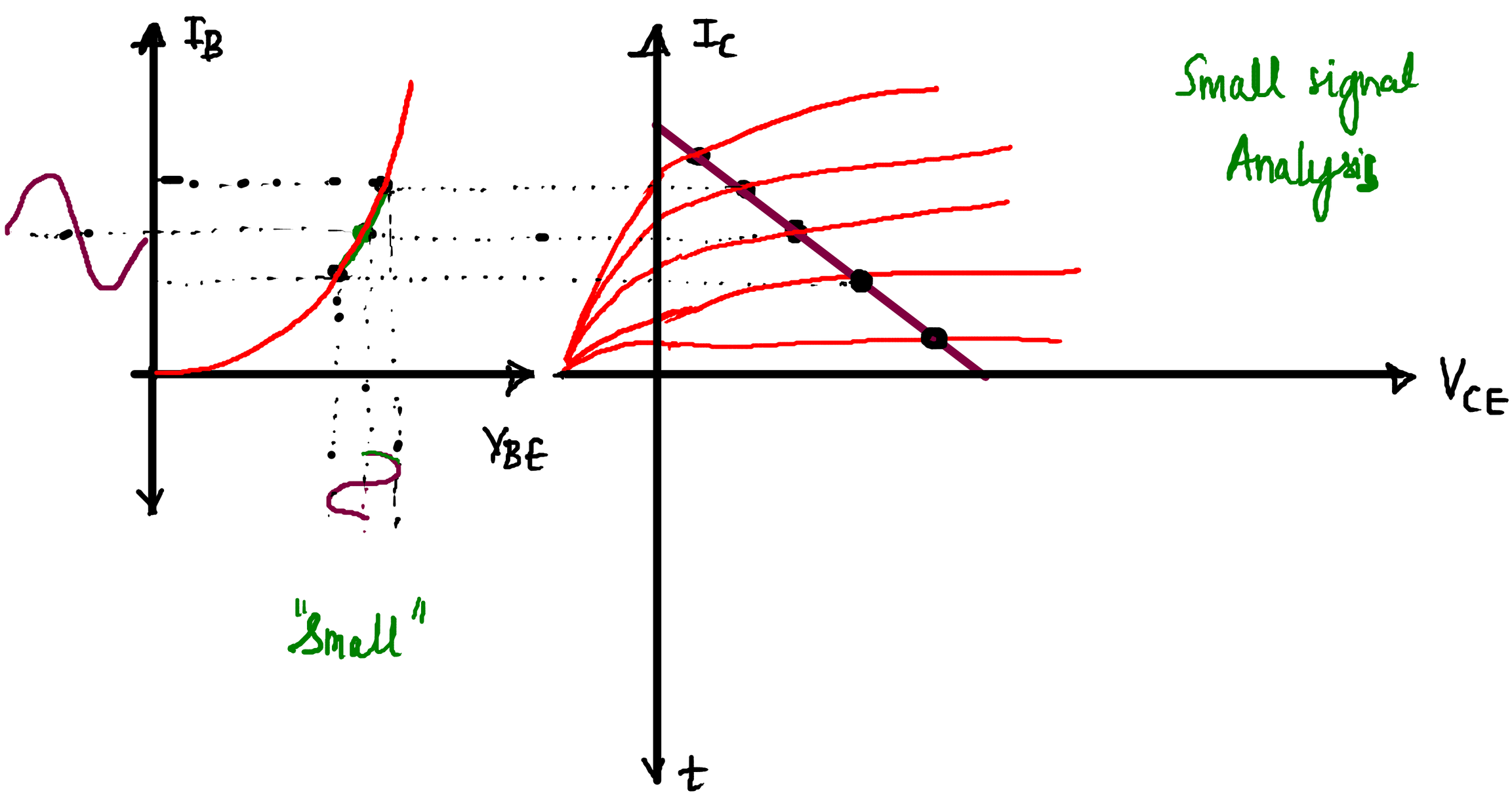
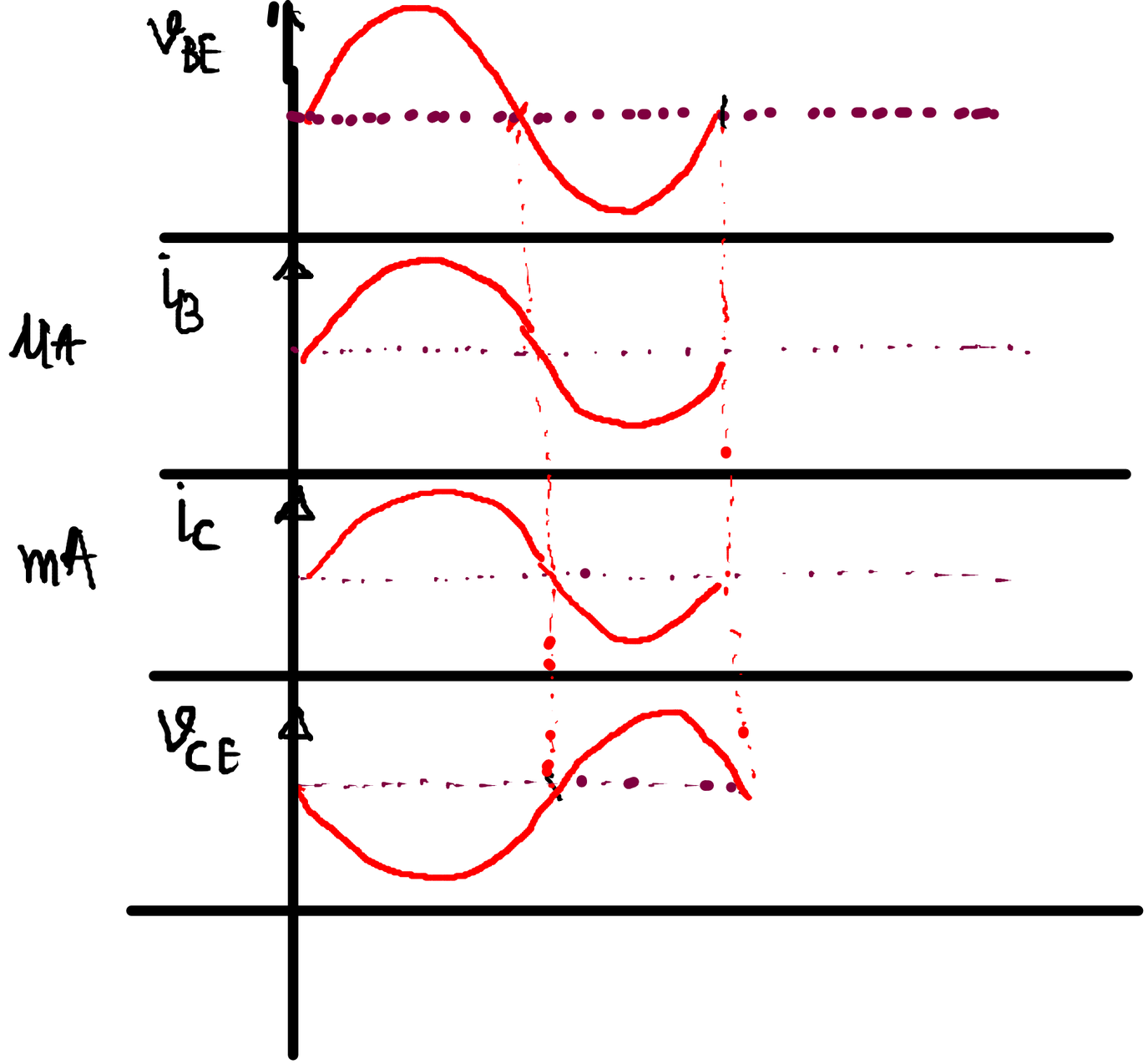


Small signal Analysis



$$i_B = I_B + i_b$$

$$v_B = V_B + v_b$$

$$I_B = I_S \left[\exp\left(\frac{V_{BE}}{V_T}\right) - 1 \right]$$

$$I_B = I_S \left[\exp\left(\frac{V_{BE}}{V_T}\right) \right]$$

$$V_B = V_B + A_m \sin(\omega t)$$

$V_T = 26mV$

$V_{BE} >> 4 V_T$

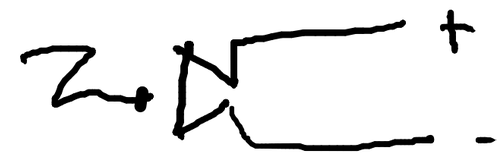
$e^{\varphi} \approx 1 + \varphi$ for $\varphi << 1$

$$\frac{V_B + A_m \sin(\omega t)}{V_T} << 1$$

$$V_B + A_m \sin(\omega t) << V_T$$

$A_m << V_T$

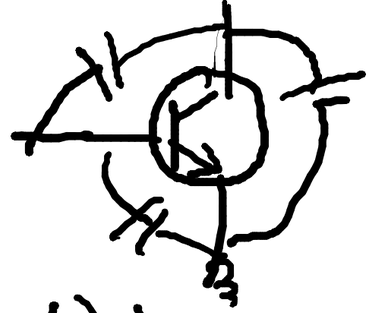
$$I_B = I_S \left[\exp\left(\frac{V_B + A_m \sin(\omega t)}{V_T}\right) \right]$$



$$= I_S \left[1 + \left(\frac{V_B + A_m \sin(\omega t)}{V_T} \right) \right]$$

$$= I_S + \frac{V_B I_S}{V_T} + \frac{A_m}{V_T} \sin(\omega t)\, I_S$$

$$i_D = I_S \left[\exp\left(\frac{V_B + A_B \sin(\omega t)}{V_T} \right) \right]$$



$$i_D = I_S \exp\left(\frac{V_B}{V_T}\right) \exp\left(\frac{A_B \sin(\omega t)}{V_T}\right)$$

$$\frac{\partial i_D}{\partial V_{BE}}$$

$$i_D = I_S \exp\left(\frac{V_B}{V_T}\right) \left[1 + \frac{A_B \sin(\omega t)}{V_T} \right]$$

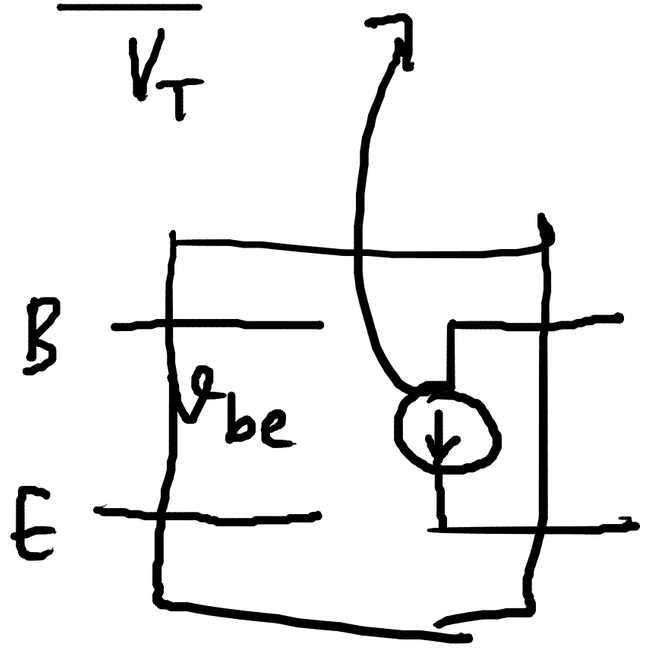
$$i_D = I_D + \frac{I_D A_B}{V_T} \sin(\omega t)$$

Transconductance

$$i_D = I_S \left[\exp\left(\frac{v_B}{V_T}\right) \right]$$

$$I_C = I_S \exp\left(\frac{V_{BE}}{V_T}\right)$$

$$\downarrow g_m = \frac{\partial i_D}{\partial v_{BE}} = \frac{I_S}{V_T} \exp\left(\frac{v_B}{V_T}\right) = \frac{i_D}{V_T}$$



$$i_D = I_D + g_m A_m \sin(\omega t)$$