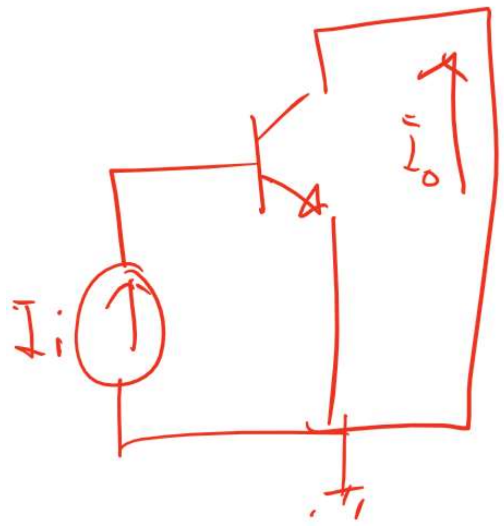
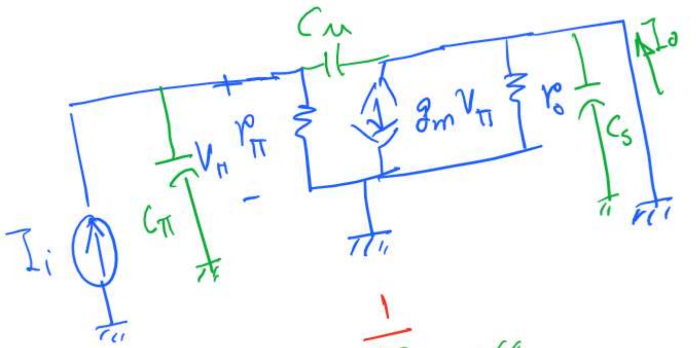
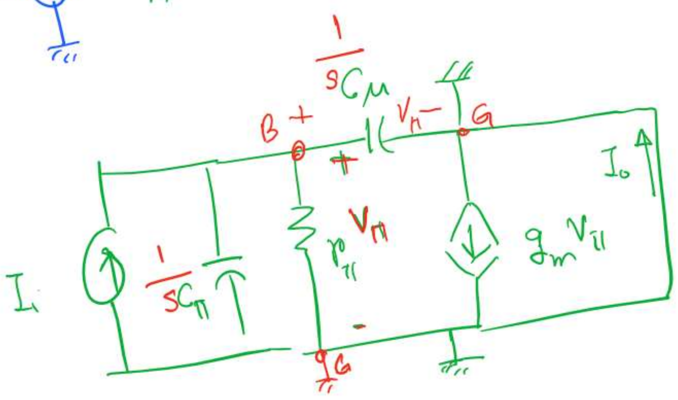


$A_{I|sc} = \frac{I_o}{I_i}$

at high frequies.





$$I_i = \frac{V_\pi}{1/sC_\pi} + \frac{V_\pi}{r_\pi} + \frac{V_\pi}{1/sC_\mu}$$

$$= V_\pi\left[s(C_\pi + C_\mu) + \frac{1}{r_\pi}\right]$$

$$I_o = g_m V_\pi - \frac{V_\pi}{1/sC_\mu} = V_\pi\left[g_m - sC_\mu\right]$$

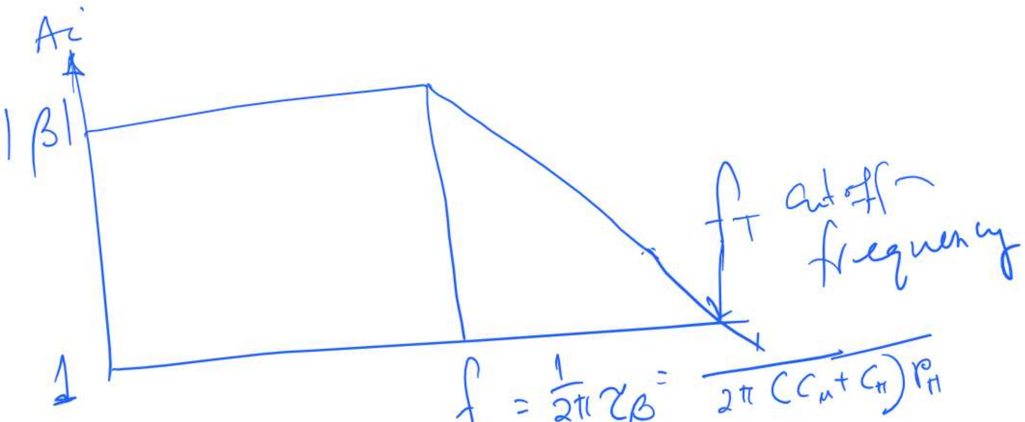
$$A_i = \frac{I_o}{I_i} = \frac{\cancel{V_\pi}\left[g_m - sC_\mu\right]}{\cancel{V_\pi}\left[s(C_\pi + C_\mu) + \frac{1}{r_\pi}\right]}$$

$$= \frac{g_m r_\pi - sC_\mu r_\pi}{1 + s r_\pi (C_\pi + C_\mu)}$$

$$\simeq \frac{g_m r_\pi}{1 + s r_\pi (C_\pi + C_\mu)}$$

$$= \frac{\beta}{1 + s\tau_\beta}$$

$$\tau_\beta = r_\pi (C_\pi + C_\mu)$$



$$f_\beta = \frac{1}{2\pi \tau_\beta} = \frac{1}{2\pi (C_\mu + C_\pi) r_\pi}$$

Beta cutoff freq.

$$A_i = \frac{\beta}{1 + s r_\pi (C_\pi + C_\mu)}$$

$$A_i(\omega) = \frac{\beta}{1 + j\omega r_\pi (C_\pi + C_\mu)}$$

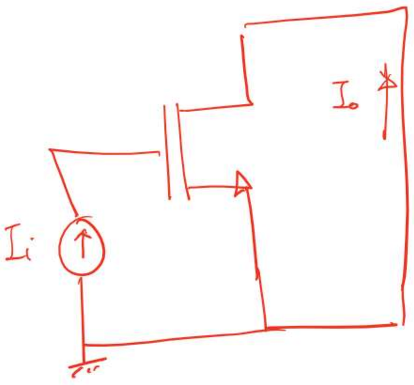
$$|A_i| = \frac{\beta}{\sqrt{1 + [\omega r_\pi (C_\pi + C_\mu)]^2}} \simeq \frac{\beta}{\omega r_\pi (C_\pi + C_\mu)}$$

$$1 = \frac{\beta}{\omega_T r_\pi (C_\pi + C_\mu)} \qquad \therefore \omega_T = \frac{\beta}{r_\pi (C_\mu + C_\pi)}$$

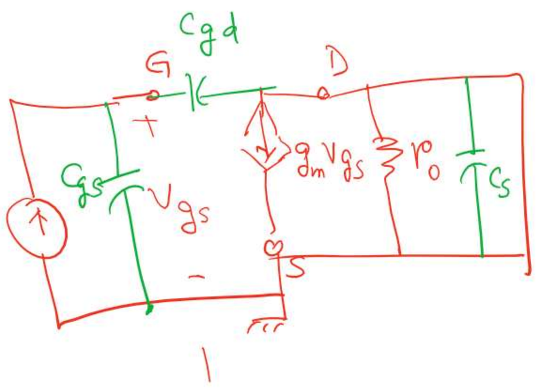
$$f_T = \frac{\beta}{2\pi r_\pi (C_\mu + C_\pi)}$$

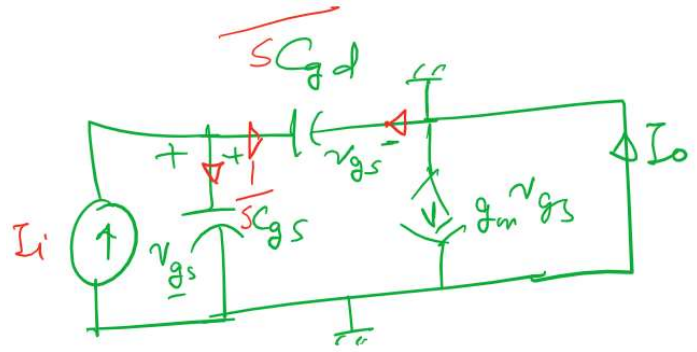
$$\underset{\text{cutoff freq}}{f_T} = \underset{\text{gain}}{\beta}\ \underset{\text{beta freq}}{f_\beta}$$

$$f_T = \text{Gain} \times BW$$



$$A_i \Big|_{sc} = \frac{I_o}{I_i}$$





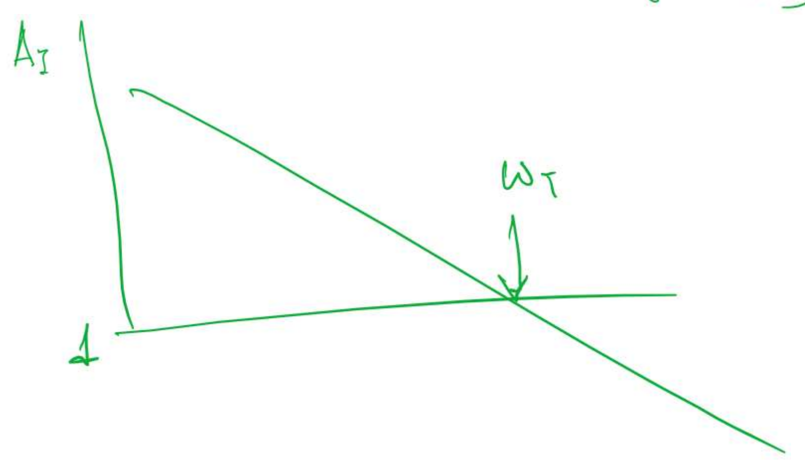
$$I_i = \frac{v_{gs}}{\frac{1}{sC_{gs}}} + \frac{v_{gs}}{\frac{1}{sC_{gd}}} = v_{gs}\, s\left[C_{gs} + C_{gd}\right]$$

$$I_o = g_m v_{gs} - \frac{v_{gs}}{\frac{1}{sC_{gd}}} = v_{gs}\left[g_m - sC_{gd}\right]$$

$$\therefore A_I\Big|_{sc} = \frac{I_o}{I_i} = \frac{\cancel{v_{gs}}\left[g_m - sC_{gd}\right]}{\cancel{v_{gs}}\, s\left(C_{gs} + C_{gd}\right]}$$

$$= \frac{g_m - sC_{gd}}{s\left(C_{gs} + C_{gd}\right]}$$

$$\simeq \frac{g_m}{s\left(C_{gs} + C_{gd}\right)}$$



$$\left|A_i\right| = \frac{g_m}{\omega\left(C_{gd} + C_{gs}\right)}$$

$$1 = \frac{g_m}{\omega_T\left(C_{gd} + C_{gs}\right)}$$

$$\therefore \omega_T = \frac{g_m}{C_{gd} + C_{gs}}$$

$$f_T = \frac{g_m}{2\pi\left(C_{gd} + C_{gs}\right)}$$