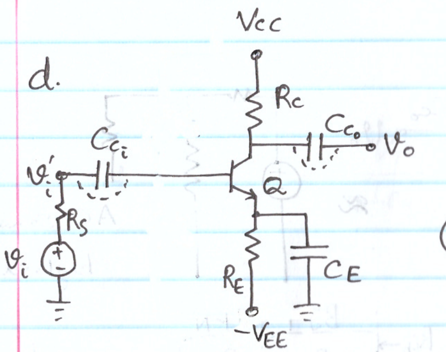
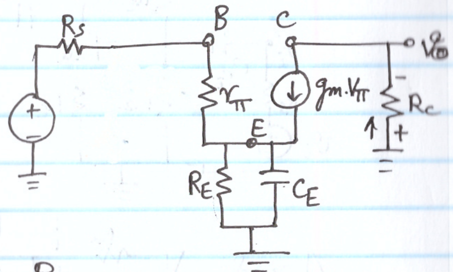
d.



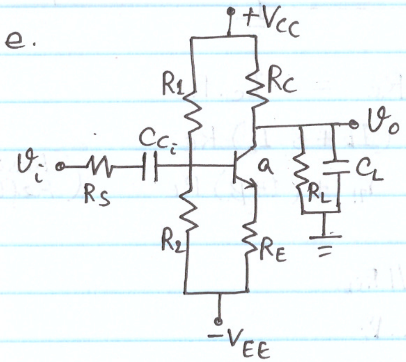


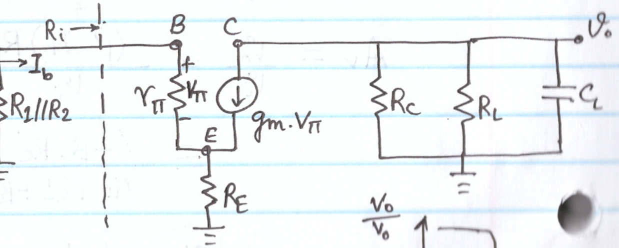
$$|A_v|_{\omega=0} = \frac{g_m \cdot r_\pi \cdot R_c}{R_s + r_\pi + (1+\beta)\,R_E}$$

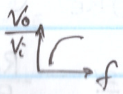
C_i & C_{co} are shorted

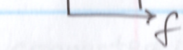
$$|A_v|_{\omega=\infty} = \frac{g_m \cdot r_\pi \cdot R_c}{R_s + r_\pi}$$

e.









Lower corner freq: $f_L = \dfrac{1}{2\pi \tau_s}$ (High Pass Filter)

Lower cut-off

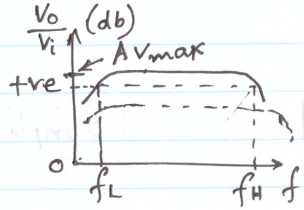
Upper corner freq: $f_H = \dfrac{1}{2\pi \tau_L}$ (Low Pass Filter)

Upper cut-off

where, $\tau_s = [R_s + (R_1 // R_2 // R_i)] \cdot C_c$

& $\tau_L = (R_c // R_L)\, C_L$

$R_i = r_\pi + (1+\beta)\, R_E$



At mid-band:

$$I_i = \frac{v_i}{R_s + (R_1 // R_2 // R_i)}$$

$$I_b = \frac{R_1 // R_2}{(R_1 // R_2) + R_i} \cdot I_i$$

$V_\pi = I_b \cdot r_\pi$

$V_o = -g_m \cdot V_\pi\,(R_c // R_L)$ $\qquad C_L \approx$ small

Gain

$$\therefore\ A_v = -g_m \cdot \cancel{V_\pi} \left[(R_c//R_L) \cdot \frac{R_1 // R_2}{(R_1//R_2) + R_i} \cdot \frac{1}{R_s + (R_1//R_2//R_i)} \right]$$

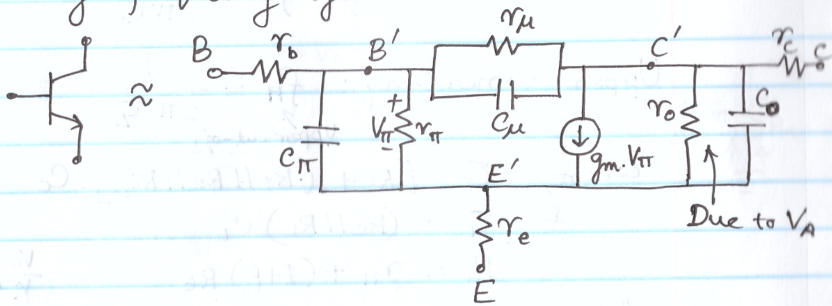
Overall:

Bandwidth: $f_{BW} = f_H - f_L$

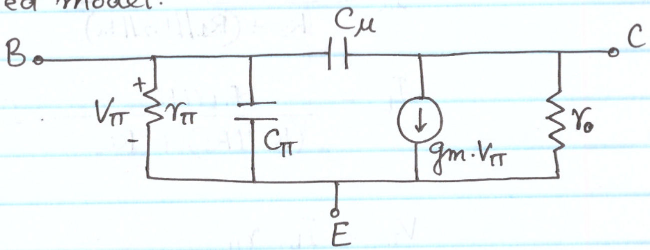
Gain Bandwidth Product: $|A_v|_{max} \cdot f_H \cong$ Constant no./value

$r_\pi, C_\pi \rightarrow$ Provides feedback (-ve)

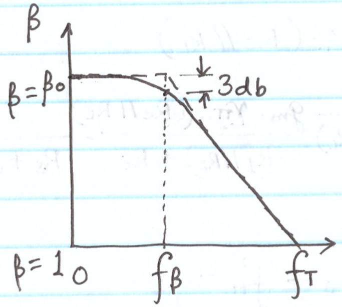
f. High frequency hybrid-π model:

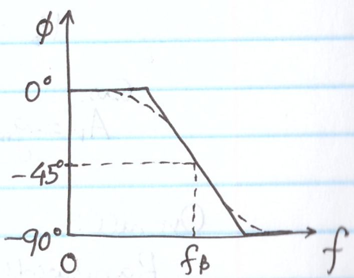


Simplified model:



BJT acts like a LPF (CE)

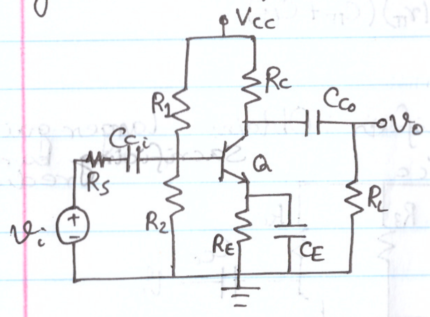




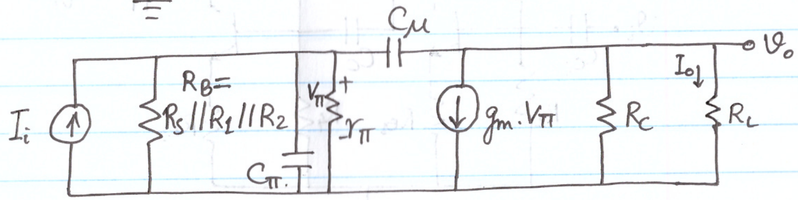
Bandwidth:
$$f_\beta = \frac{1}{2\pi r_\pi (C_\pi + C_\mu)}$$

Gain Bandwidth Product:
$$f_T = \beta_o \left[\frac{1}{2\pi r_\pi (C_\pi + C_\mu)}\right] = \frac{g_m}{2\pi (C_\pi + C_\mu)}$$

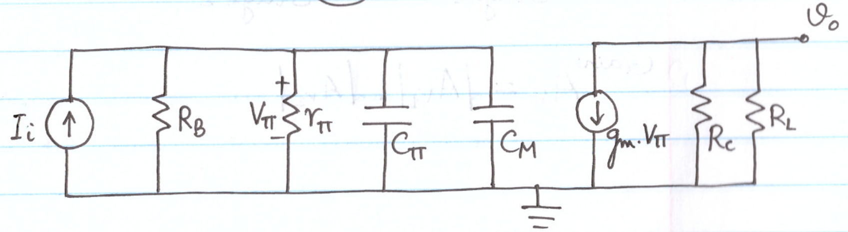
g. Miller effect & Miller $\rightarrow$ Theorem Capacitance: High freq.



Convert v_i into a I-source & draw the equ. ckt/model



or



where, $C_M = C_\mu [1 + g_m (R_C // R_L)] = C_\mu [1 + |A_v|]$

$$v_o = -g_m . V_\pi (R_C // R_L)$$
$$V_\pi = I_i \left[(R_B // r_\pi) // \left(\frac{1}{j\omega C_\pi}\right) // \left(\frac{1}{j\omega C_M}\right)\right]$$
$$= I_i \frac{R_B // r_\pi}{1 + j\omega (R_B // r_\pi)(C_\pi + C_M)}$$
$$A_i = \frac{I_o}{I_i} = -g_m \left(\frac{R_C}{R_C + R_L}\right)\left[\frac{R_B // r_\pi}{1 + j\omega (R_B // r_\pi)(C_\pi + C_M)}\right]$$