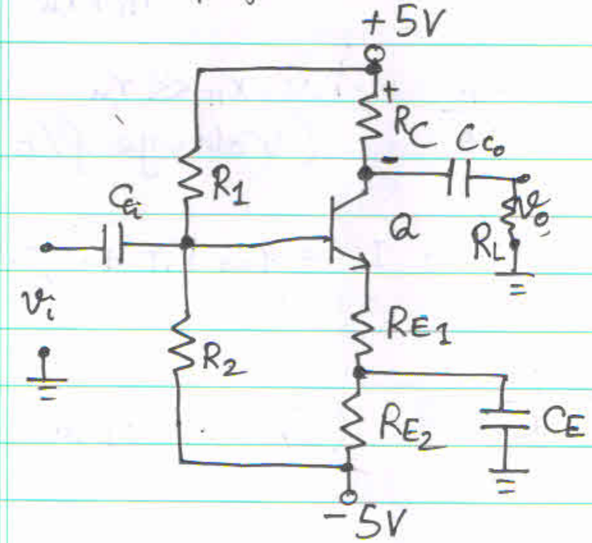
19. Types of Amplifiers:

- Voltage → v_i, v_o
- Current → i_i, i_o
- Transresistance → i_i, v_o
- Transconductance → v_i, i_o

20. CE amplifier with Emitter Bypass Capacitor:

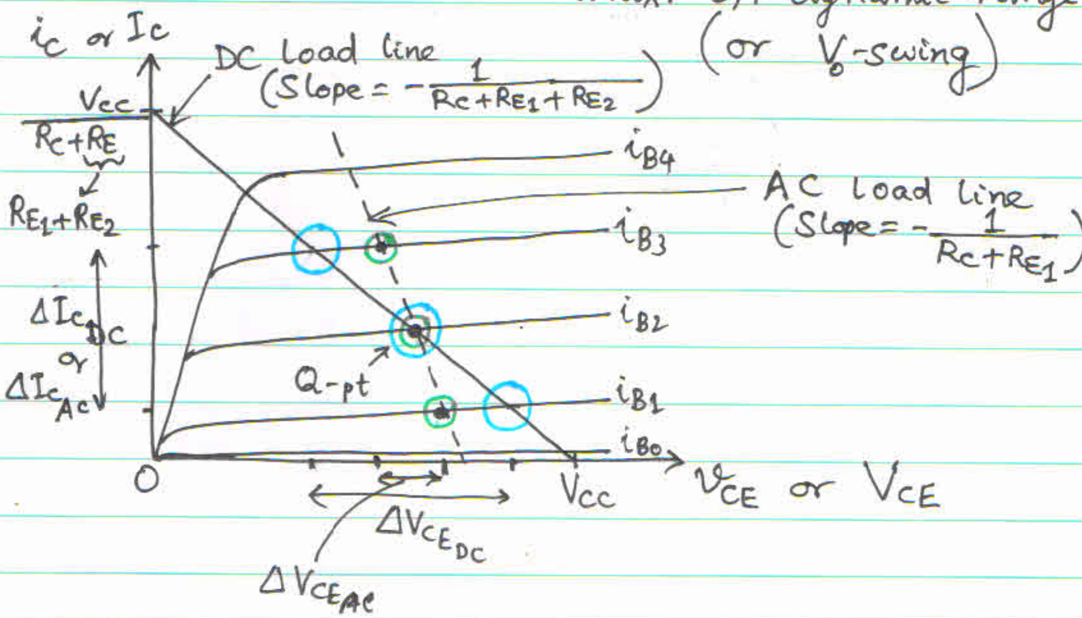


w/o C_E $\{ R_E \uparrow, A_v \downarrow$

with C_E $\left\{ \begin{array}{l} X_C \downarrow_{HF\,(ac)} \quad R_E \downarrow \\ I_E \uparrow \quad I_C \uparrow \quad A_v \uparrow \end{array} \right.$

$$\left[X_{C_E} = \frac{1}{2\pi f C_E} \right]$$

21. AC Load Line Analysis: & its relation with max. O/P dynamic range (or V_o-swing)

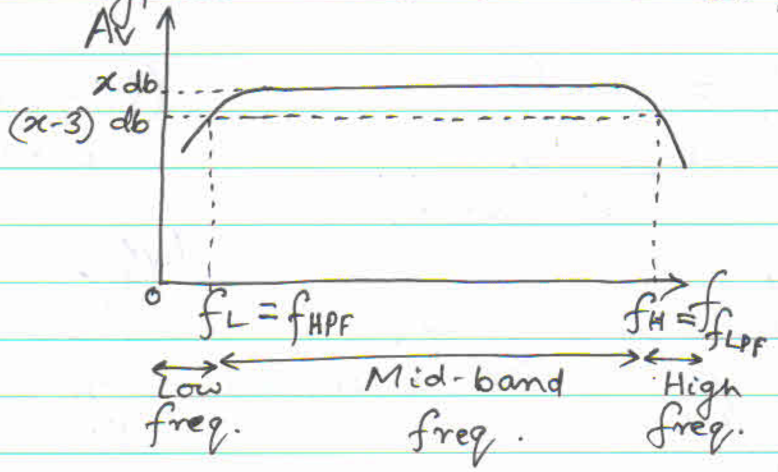


Due to $C_E \,//\, R_{E_2}$, at high frequencies, R_{E_2} is bypassed/shorted through C_E, therby increases/compensates gain at high frequencies.

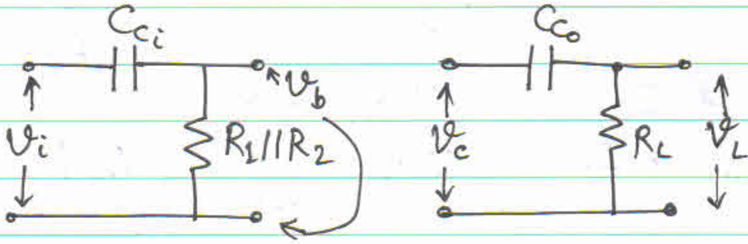
Due to C_E & AC load line, max. O/P V-swing/range changes for a particular I/P V-swing/range, provided the amp. works in forward-active region (or linear mode/region).

22. Frequency response analysis.

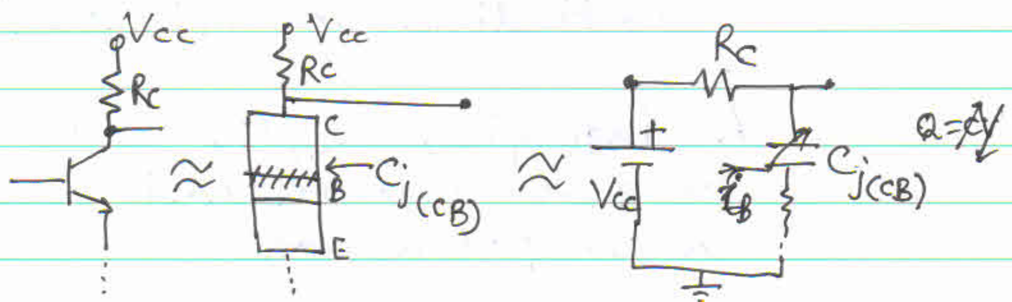
Typical Bandwidth : Band-pass filter + gain



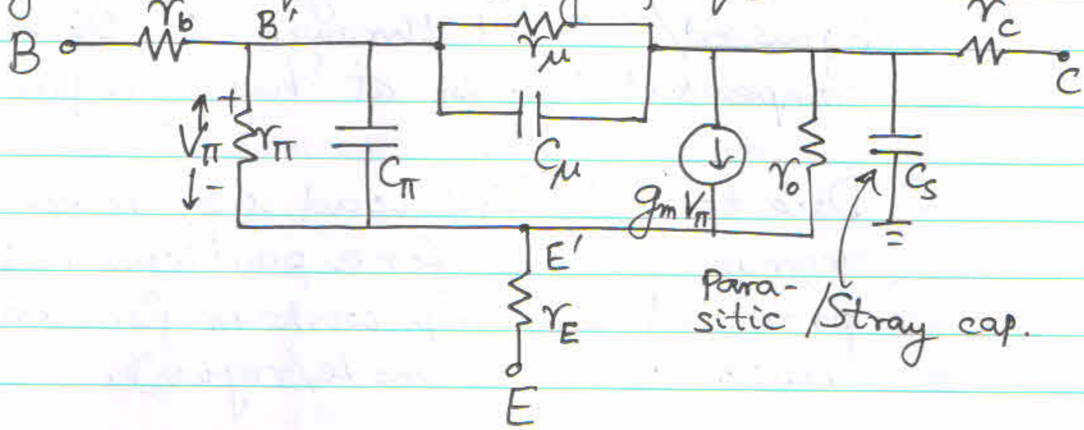
$x > 0$



HPF HPF

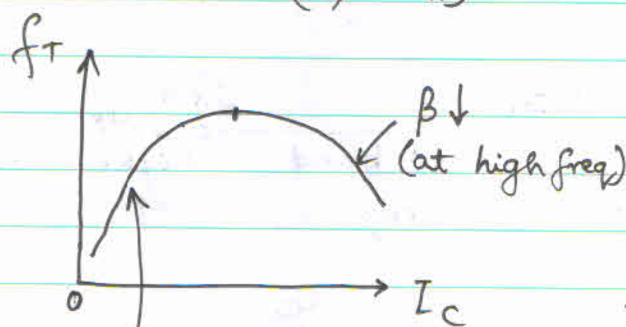


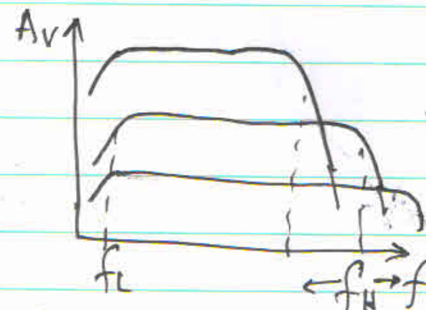
Hybrid-π eqv. ckt. (high freq.)



$$f_\beta = \frac{1}{2\pi\, r_\pi (C_\pi + C_\mu)}$$ (3 db. cut-off) LPF

GBW → $$f_T = \beta_o \cdot f_\beta = \frac{g_m}{2\pi (C_\mu + C_\pi)}$$ (Gain-bandwidth product)





$BW = f_H - f_L$

$g_m \propto I_C$ $\left(\because g_m = \frac{I_{Cq}}{V_T}\right)$

r_π & $C_\pi \rightarrow I_C$ $\left(\because r_\pi = \frac{V_T}{I_{Bq}}\right)$

$A_V\uparrow$ $BW\downarrow$

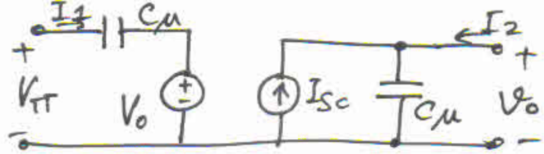
23. Miller effect

↳ Feedback multiplication.

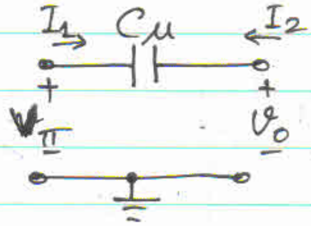
At high freq, C_{C_i}, C_{C_o} & C_E are considered to be short-circuited. And, C_μ connects O/P to I/P.

$C_\mu \rightarrow$ 2-port network.

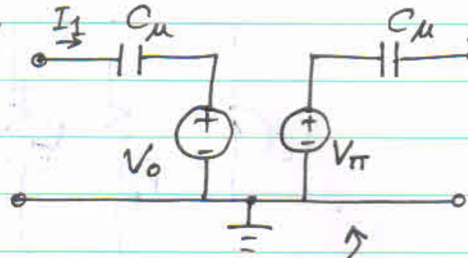
Norton's equivalent → $I_{sc} = \dfrac{V_\pi}{\left(\frac{1}{j\omega C_\mu}\right)}$



<1pF



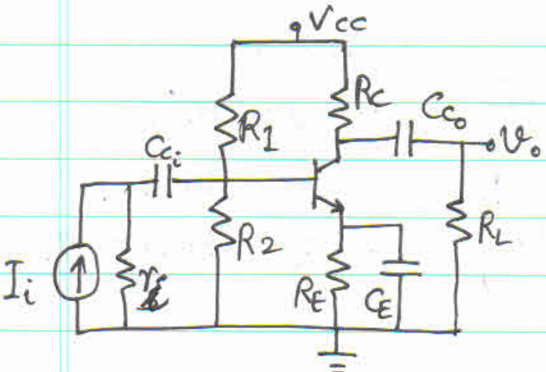
$\approx$ or

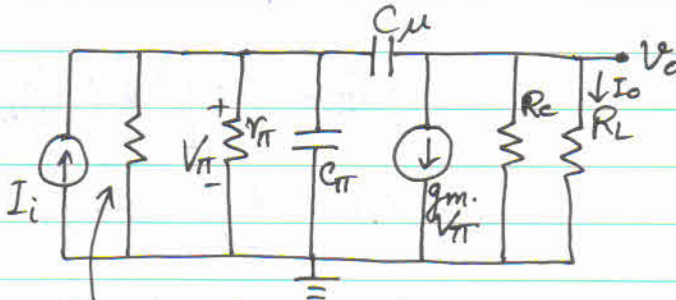


Thevenin's equivalent.

$$C_\mu = \frac{g_m}{\omega} \leftarrow \text{Angular freq}$$

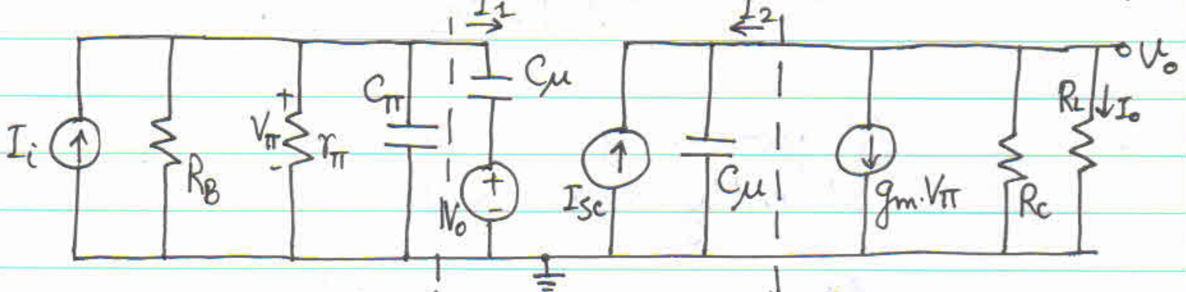
$$\Rightarrow f = \frac{g_m}{2\pi C_\mu} \quad (\text{freq. at which } V_o = V_\pi)$$





$R_B = r_i // R_1 // R_2$

(Expanded into)



$I_{sc} = j\omega C_\mu V_\pi$

C_M

Match:

$$Z_{C_\mu} = Z_{(R_C // R_L)}$$

$$\Rightarrow \frac{1}{\omega . C_\mu} = R_C // R_L$$

$$\therefore f = \frac{1}{2\pi C_\mu (R_C // R_L)}$$

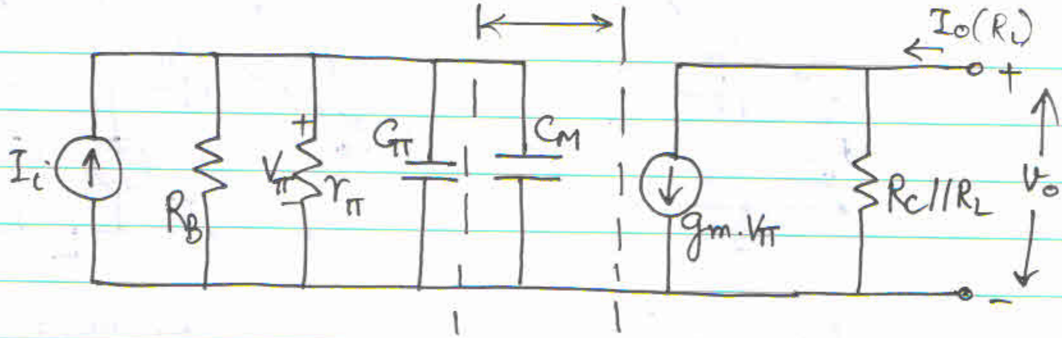
$g_m V_\pi \gg I_{sc}$ if

$$V_o = -(g_m . V_\pi)(R_C // R_L)$$

$$I_o = -(g_m . V_\pi)\frac{R_C}{R_C + R_L}$$

Ckt. segment in between the dotted lines can be replaced by C_M

$$C_M = C_\mu \left[1 + g_m (R_C // R_L)\right] \quad (\text{Miller Capacitance})$$



Simplified hybrid-π eqv. ckt. with C_M

I/P capacitance is increased $\Rightarrow C_\pi + C_M$.

$$V_\pi = I_i \left[(R_B // r_\pi) // \left(\frac{1}{j\omega C_\pi} \right) // \left(\frac{1}{j\omega C_M} \right) \right]$$

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

3 db cut-off freq.

$$\hookrightarrow f_{3db} = \frac{1}{2\pi (R_B // r_\pi)(C_\pi + C_M)}$$

If you neglect C_μ (or $C_M = 0$), the result is slightly inaccurate

Also, $C_M = C_\mu (1 + |A_v|)$