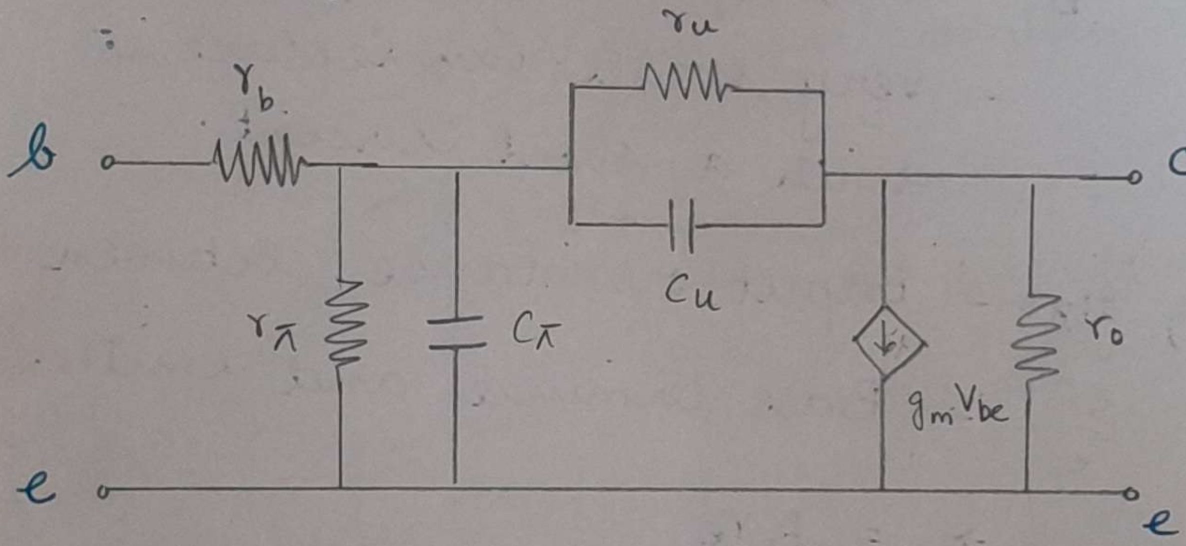
Hybrid - π Model. [Giacaletto model] [Video lecture]

- important model
- widely used

because it can be used for

- High frequency small signals.
- After few simplifications can be used for low frequency small signals.



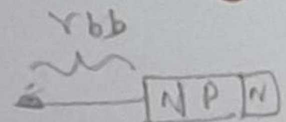
- reason.
  - include parameters that do not appear in the hybrid model.
  - These parameters provide more accuracy for high frequencies.
  - Interelectrode Capacitance.

$X_c = \frac{1}{2\pi f c}$

a) C_u – few P.F [Transition Capacitance]
- to represent early effect

b) C_π – diffusion Capacitance
- represents minority carriers in the base region.
- less than 1pF or few PF

c) r_b – base spreading resistance or bulk resistance
- very small - can replace it with a short circuit.
- resistance b/w terminal & SC



d) r_π – input resistance between
- Base terminal and emitter terminal

$\rightarrow$ $= \beta r_e$ [due to DL)

e) r_u – very large → due to DL and is always high
- replace it with open circuit

f) r_o – output resistance between collector and emitter terminal.

g) $g_m V_{be}$ – voltage dependent current source. Value of this change due to change in voltage.

g_m = transconductance

$$= \left. \frac{\text{Output current}}{\text{Input voltage}} \right|_{\text{Output voltage} = 0}$$

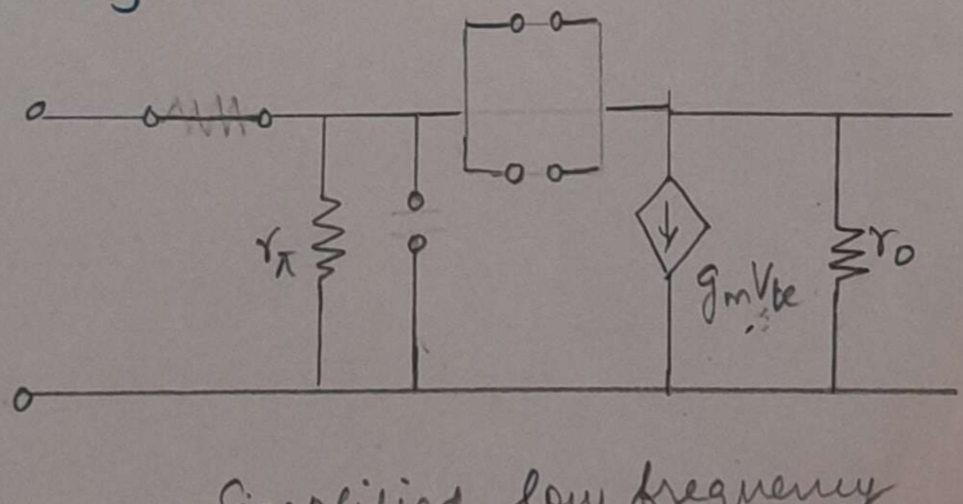
$$= \left. \frac{I_C}{V_{BE}} \right|_{V_{CE} = 0}$$

$$g_m = \frac{i_c}{V_T}$$ (can also be written as)

Hybrid π model for low frequency signals

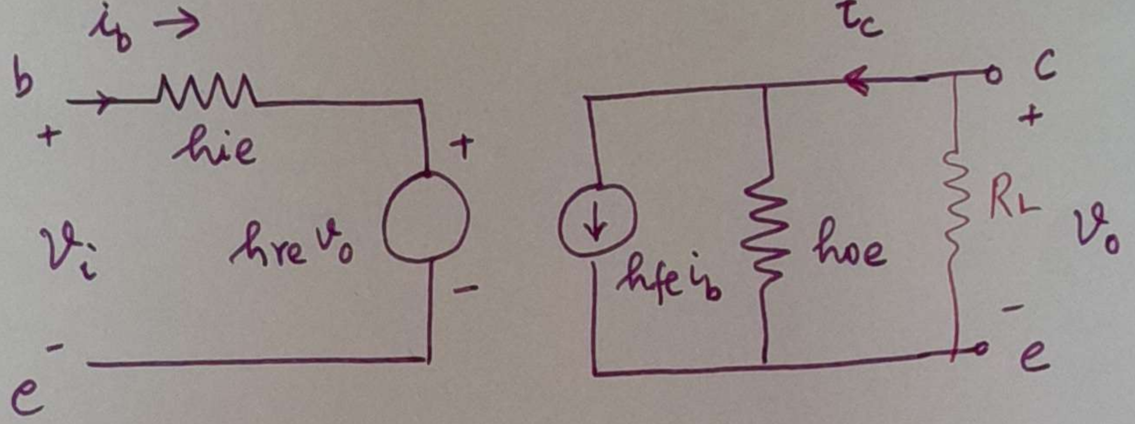
r_b = very small ; r_u = very large.
(SC) (OC)

$\left.\begin{matrix} C_u \\ C_\pi \end{matrix}\right\}$ = large reactances for low frequencies



Simplified low frequency hybrid-π model.

Approximate hybrid equivalent model.



$1/h_o$ = resistance $\gg R_L$

$h_r = \frac{v_i}{v_o}$ $\qquad v_o \gg v_i$

If

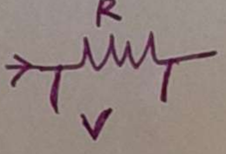
R↓ V = 0 $\qquad V = I R$

i.e drop = 0

So, $h_r \simeq 0$

So, resistance low - Short circuit

$\frac{5}{50} \simeq I$



So

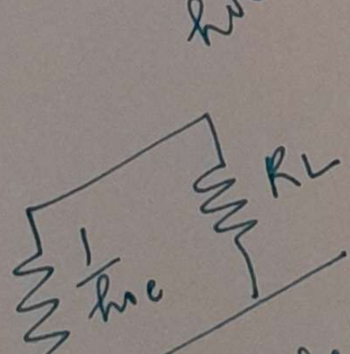
h_{oe} = very small

mʊ

$\frac{1}{h_{oe}}$ is large.

$\frac{3 \times 10}{3+10}$

$\frac{30}{13} \simeq 3$



parallel combination $\rightarrow$ $\frac{1}{h_{oe}} \parallel R_L$ ↑ ↓

$\simeq R_L$