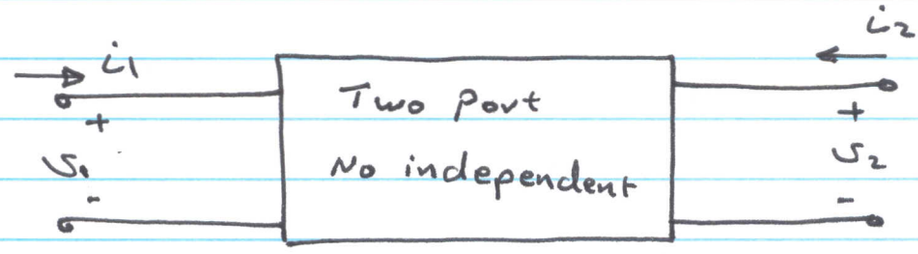
Ac Small Signal Equivalent Circuit For BJT



hybrid parameters : h- parameters :

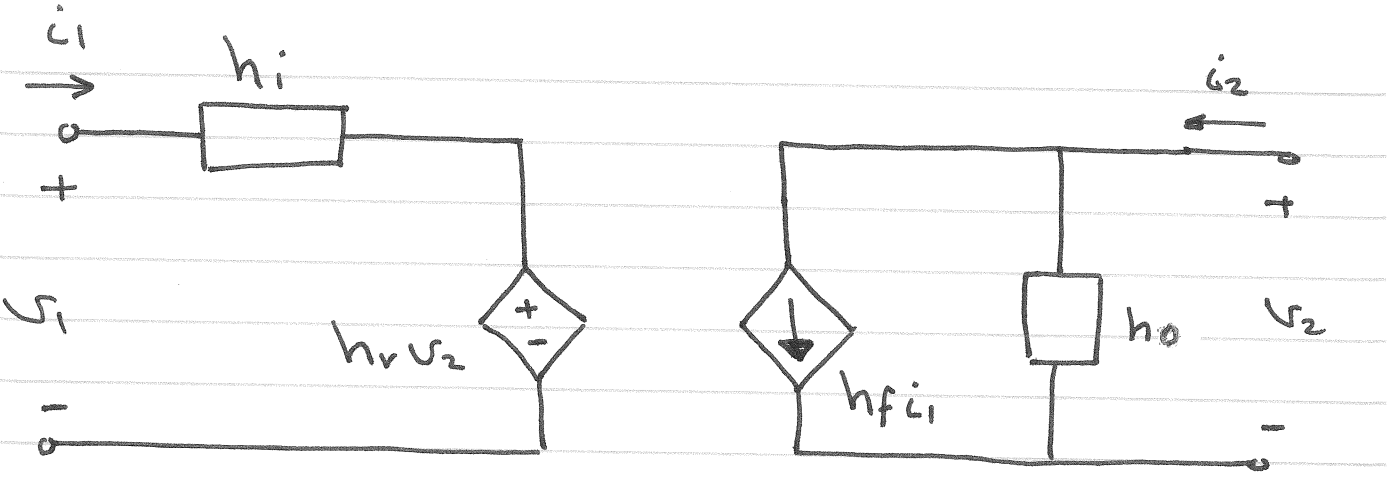
$$v_1 = h_{11} i_1 + h_{12} v_2$$
$$i_2 = h_{21} i_1 + h_{22} v_2$$

$$h_{11} = \left.\frac{v_1}{i_1}\right|_{v_2=0}$$ short circuit, input impedence, Ω (h_i)

$$h_{12} = \left.\frac{v_1}{v_2}\right|_{i_1=0}$$ open circuit, reverse voltage ratio (h_r)

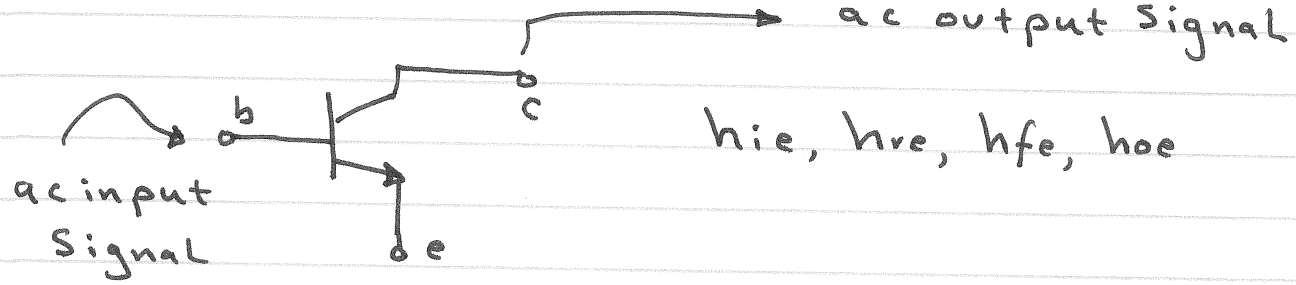
$$h_{21} = \left.\frac{i_2}{i_1}\right|_{v_2=0}$$ short circuit, forward current ratio (h_f)

$$h_{22} = \left.\frac{i_2}{v_2}\right|_{i_1=0}$$ open circuit, output admittance, $\mho$ (h_o)

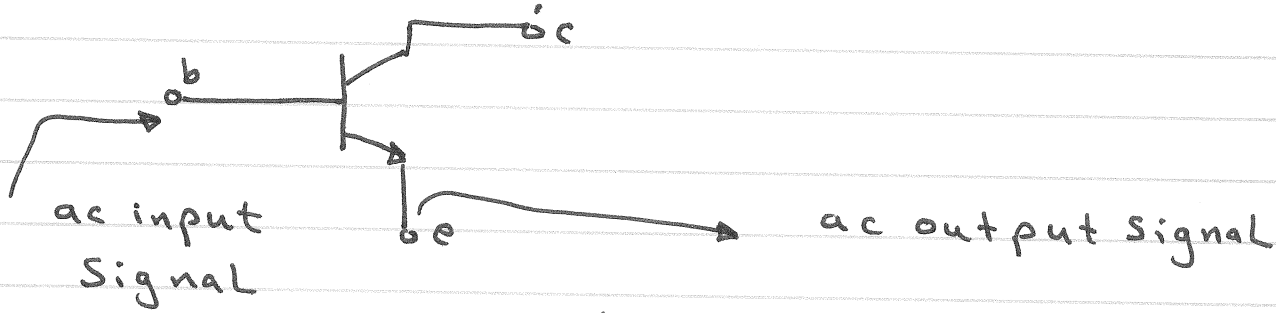


Transistor Configuration :

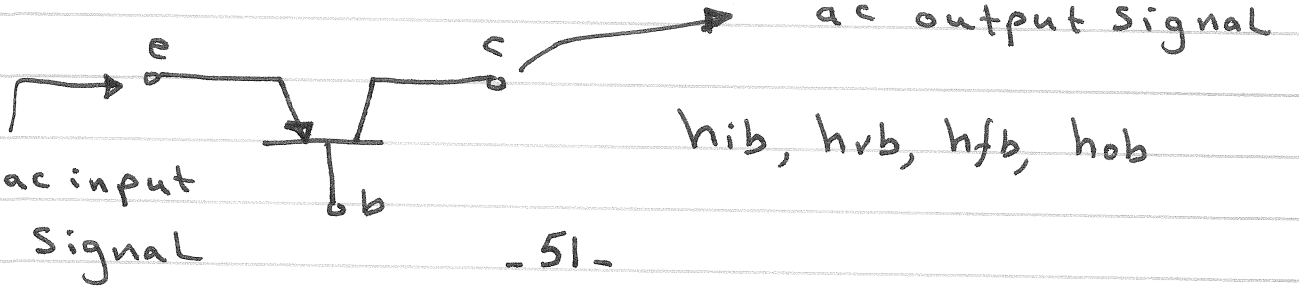
1. Common emitter :



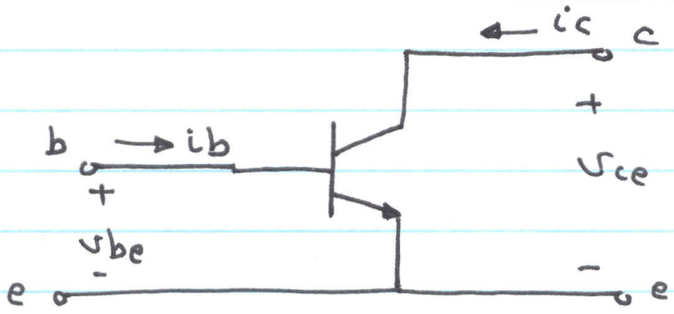
2. Common Collector :



3. Common base :

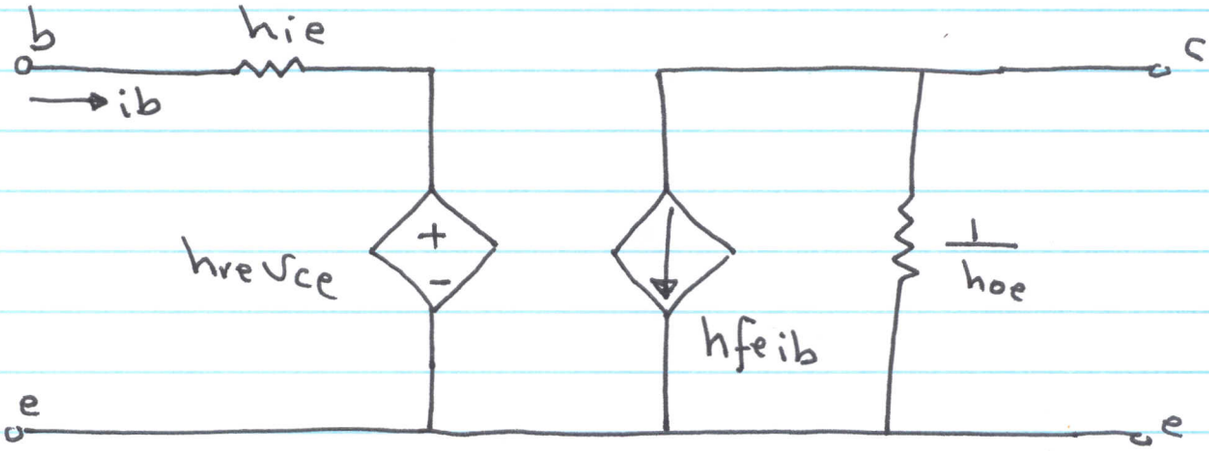


Common emitter and Common Collector

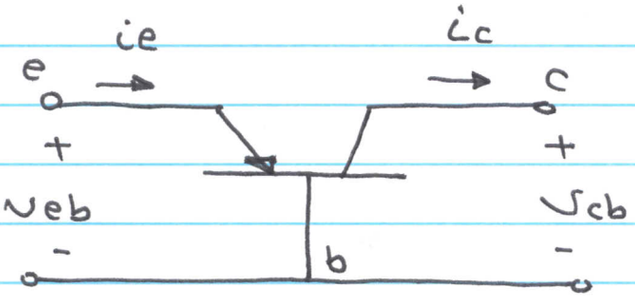


$$v_{be} = h_{ie}\, i_b + h_{re}\, v_{ce}$$

$$i_c = h_{fe}\, i_b + h_{oe}\, v_{ce}$$

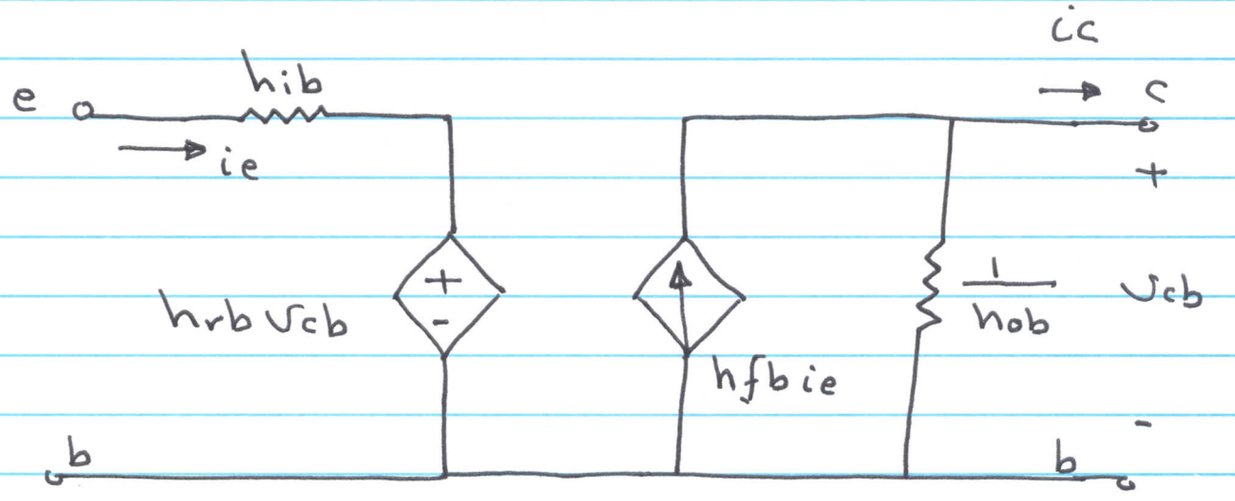


Common base



$$v_{eb} = h_{ib}\, i_e + h_{rb}\, v_{cb}$$

$$i_c = h_{fb}\, i_e + h_{ob}\, v_{cb}$$



h-parameter typical values

$h_{ie} = 1600\ \Omega$

$h_{oe} = 20 \times 10^{-6}\ \Omega$

$h_{fe} = 80$

$h_{re} = 2 \times 10^{-4}$

$h_{oe} = 20 \times 10^{-6} \longrightarrow 0$

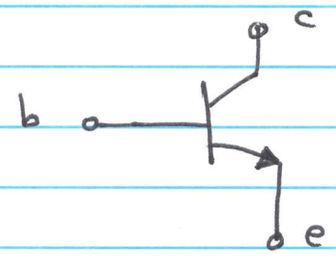
$\therefore$ we replace $\frac{1}{h_{oe}}$ with open circuit

$h_{re} = 2 \times 10^{-4} \longrightarrow 0$

$\therefore$ we replace $h_{re}v_{ce}$ with short circuit

Approximate BJT Models

1. Common emitter and Common Collector



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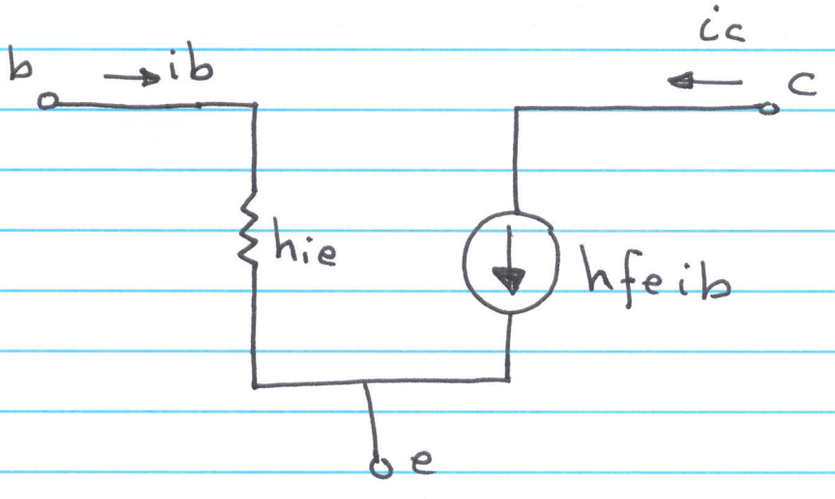
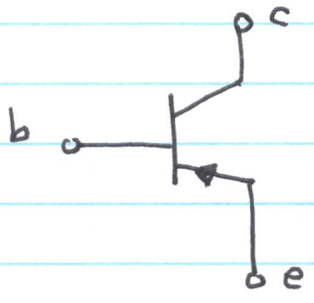


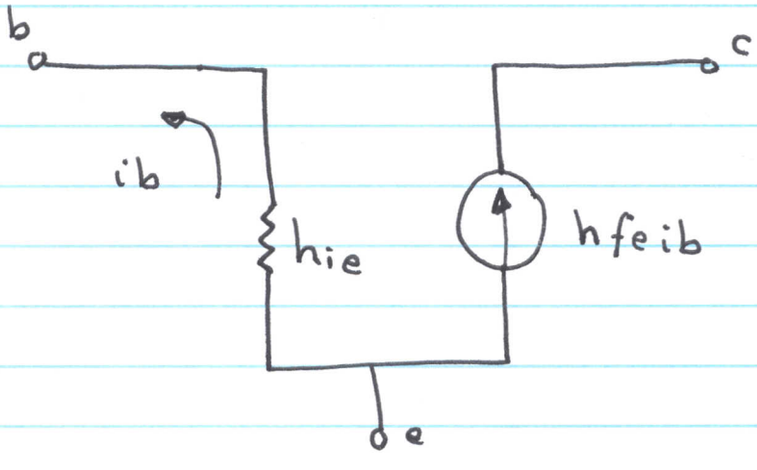
$$ic = hfe\, ib = \beta\, ib$$

$$\therefore \quad hfe = \beta$$

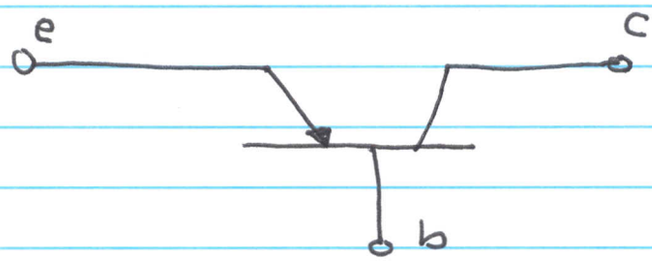
$$hie = \frac{V_T}{I_B} = \frac{\beta V_T}{I_C} = \frac{(\beta+1) V_T}{I_E}$$

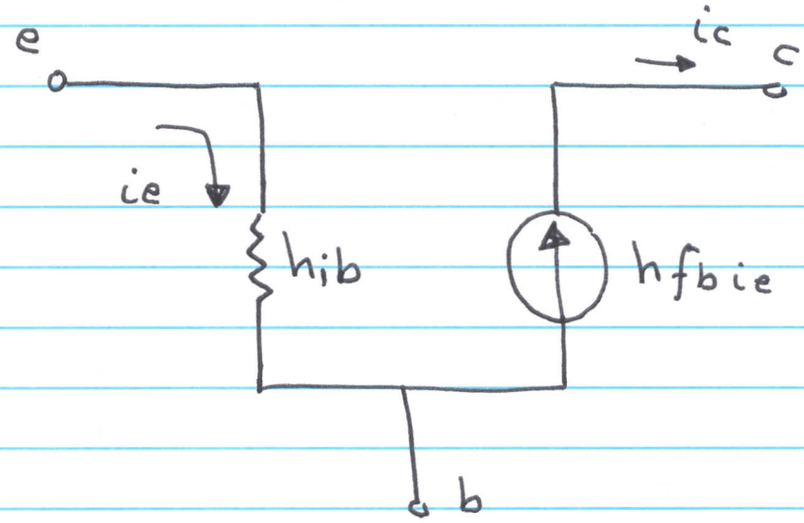


pnp



2. Common base





$$ic = h_{fb}\, ie = \alpha\, ie$$

$$\therefore \quad h_{fb} = \alpha$$

$$h_{ib} = \frac{V_T}{I_E}$$

note : $h_{ie} = (h_{fe}+1)\, h_{ib}$