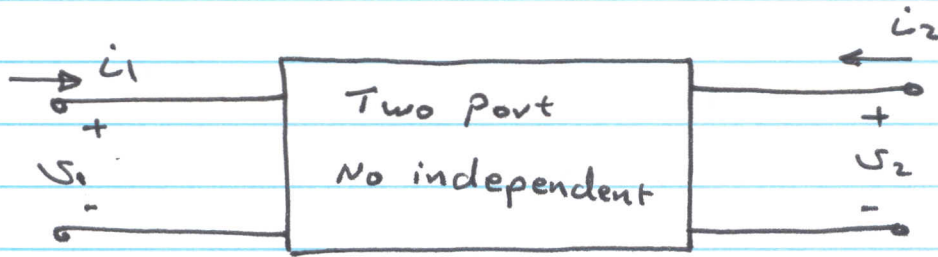


Ac Small Signal Equivalent Circuit For BJT



hybrid parameters : h-parameters :

$$V_1 = h_{11} i_1 + h_{12} V_2$$

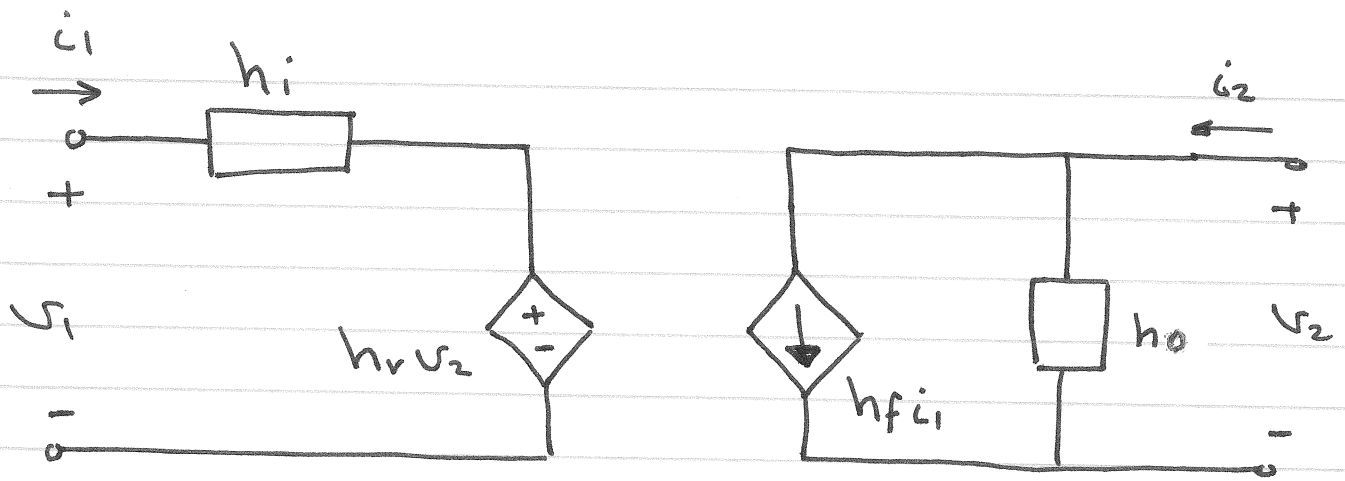
$$i_2 = h_{21} i_1 + h_{22} V_2$$

$$h_{11} = \left. \frac{V_1}{i_1} \right|_{V_2=0} \quad \text{short circuit, input impedance, } \Omega \quad (h_i)$$

$$h_{12} = \left. \frac{V_1}{V_2} \right|_{i_1=0} \quad \text{open circuit, reverse voltage ratio} \quad (h_r)$$

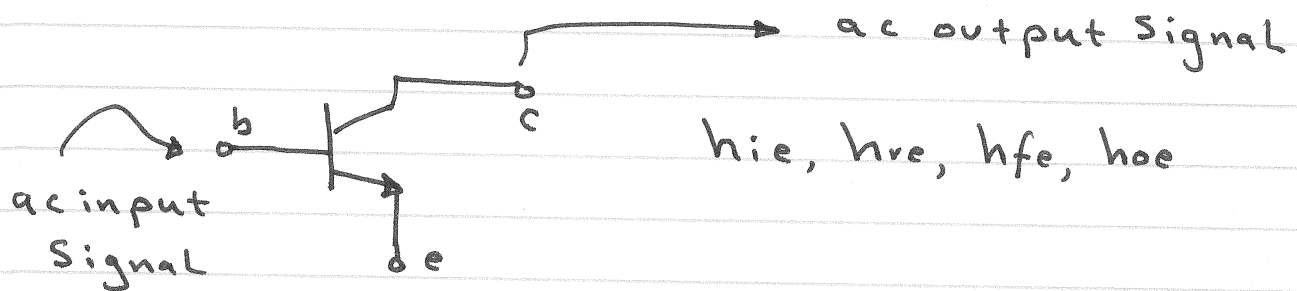
$$h_{21} = \left. \frac{i_2}{i_1} \right|_{V_2=0} \quad \text{short circuit, forward current ratio} \quad (h_f)$$

$$h_{22} = \left. \frac{i_2}{V_2} \right|_{i_1=0} \quad \text{open circuit, output admittance, } \Omega \quad (h_o)$$

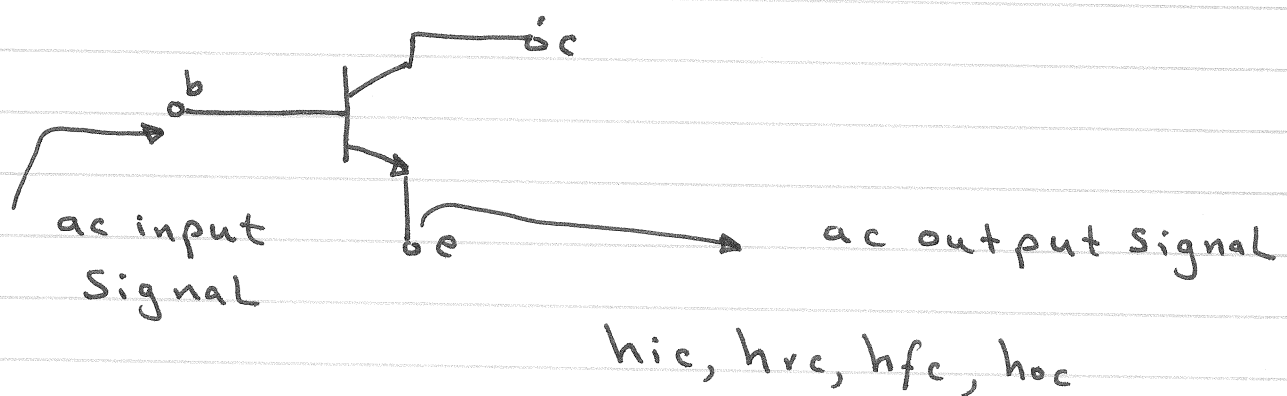


Transistor Configuration :

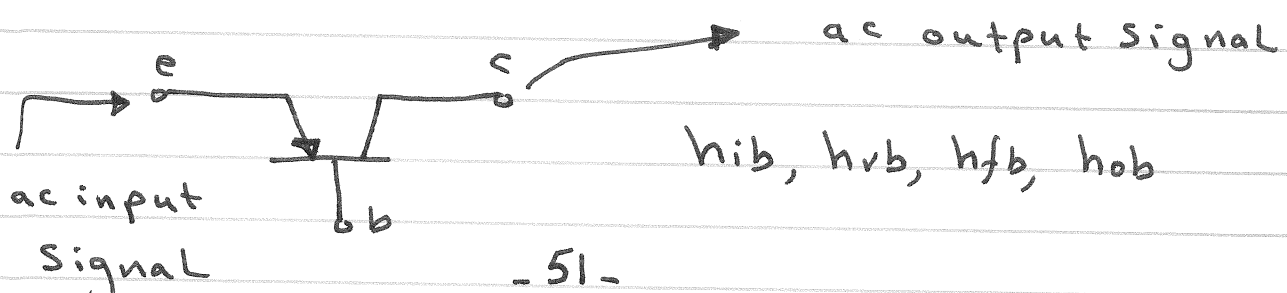
1. Common emitter :



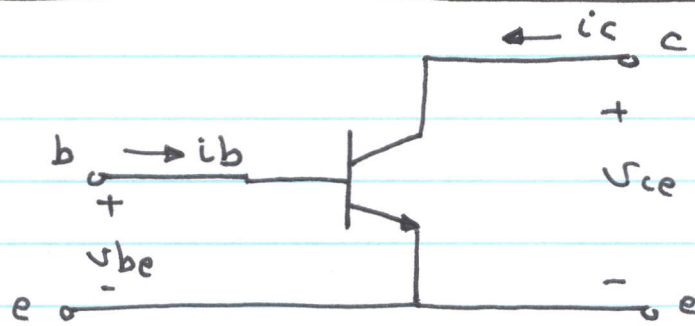
2. Common Collector :



3. Common base :

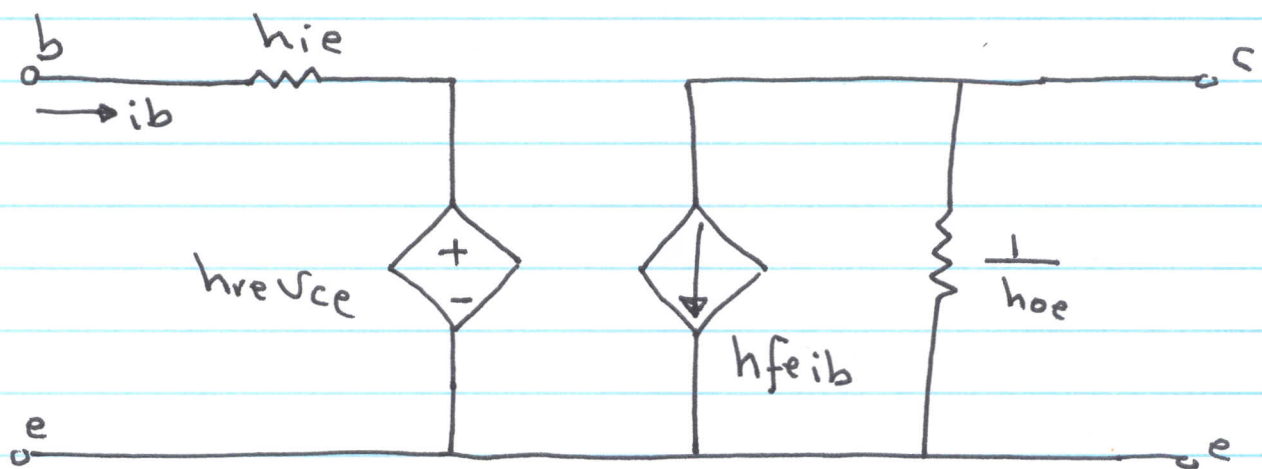


Common emitter and Common Collector

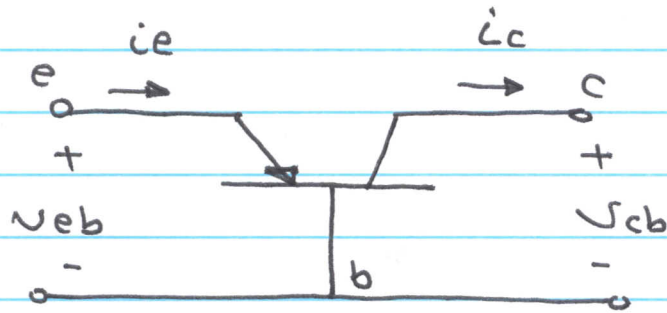


$$V_{be} = h_{ie} i_b + h_{re} V_{ce}$$

$$i_c = h_{fe} i_b + h_{oe} V_{ce}$$

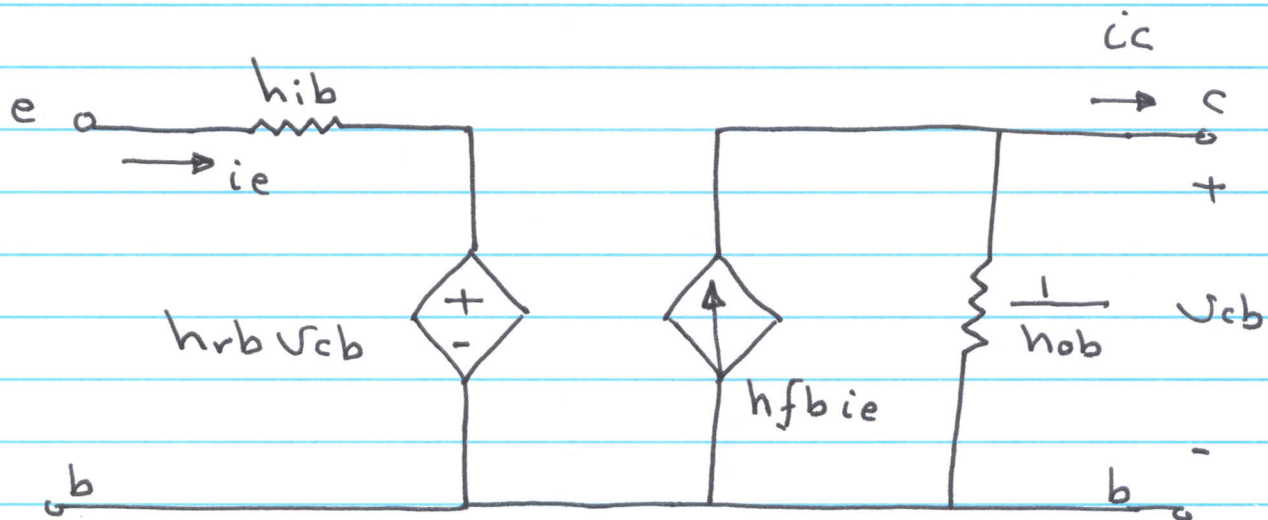


Common base



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

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



h-parameter typical values

$$h_{ie} = 1600 \Omega$$

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

$$h_{fe} = 80$$

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

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

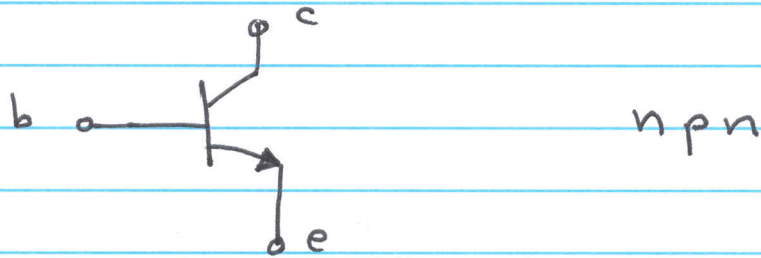
\therefore We replace $\frac{1}{h_{oe}}$ with open circuit

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

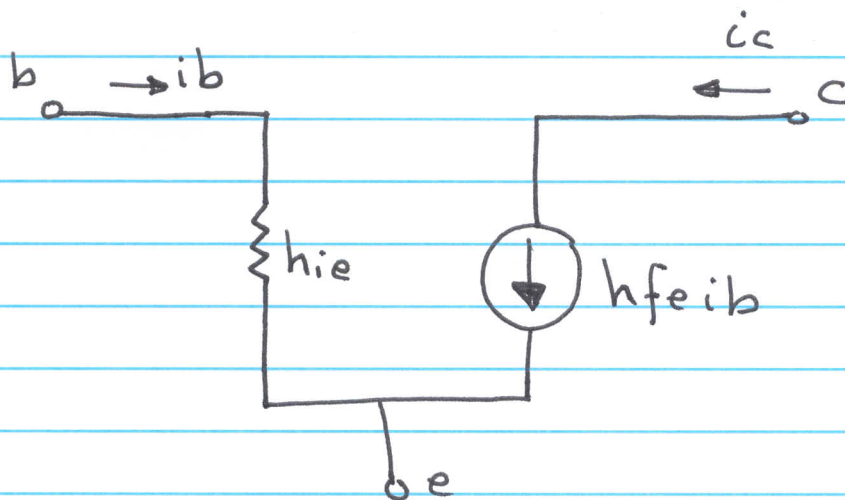
\therefore We replace $h_{re} v_{ce}$ with short circuit

Approximate BJT Models

1. Common emitter and Common Collector



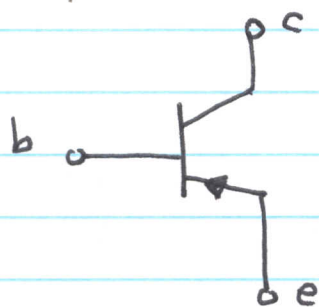
n p n



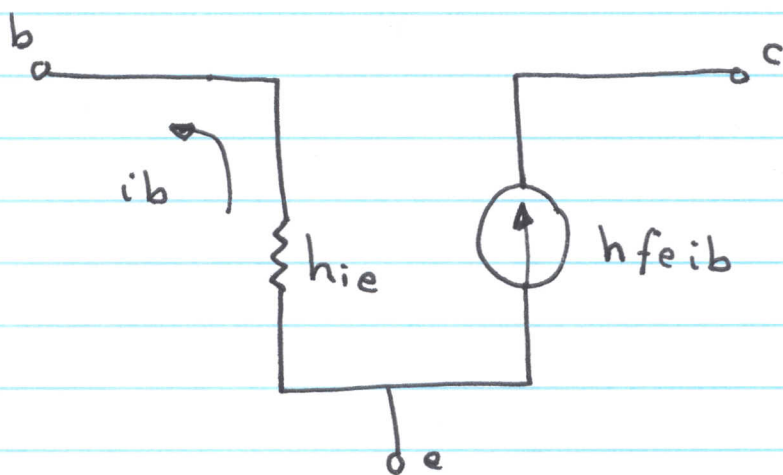
$$i_c = h_{fe} i_b = \beta i_b$$

$$\therefore h_{fe} = \beta$$

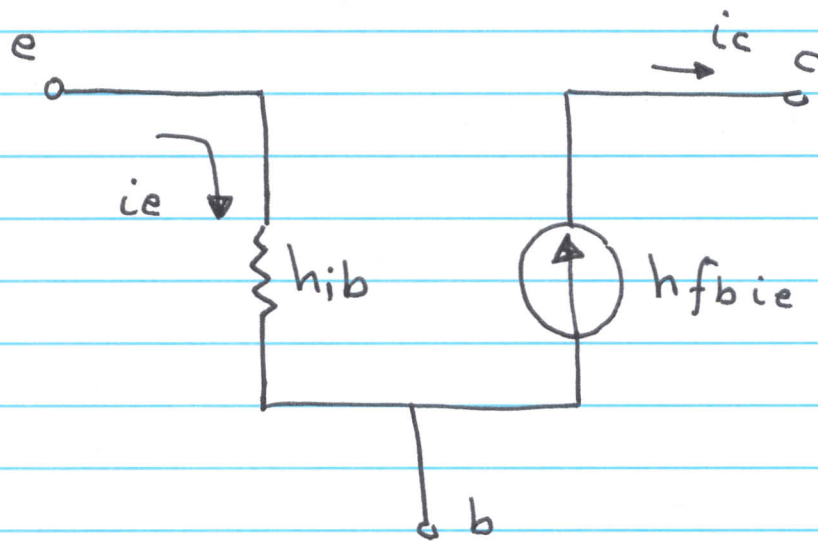
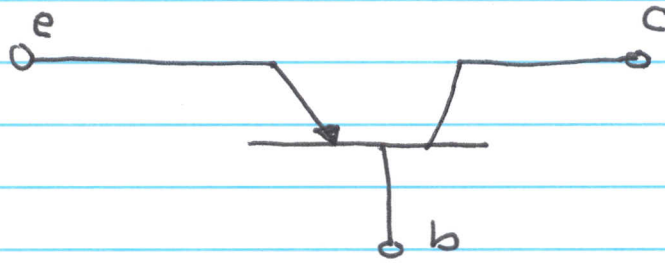
$$h_{ie} = \frac{V_T}{I_B} = \frac{\beta V_T}{I_C} = \frac{(\beta + 1) V_T}{I_E}$$



Pnp



2. Common base



$$i_c = h_{fb} i_e = \alpha i_e$$

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

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

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