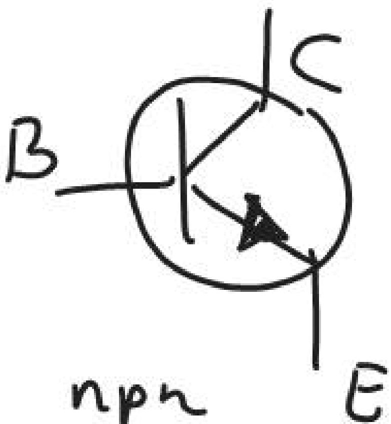
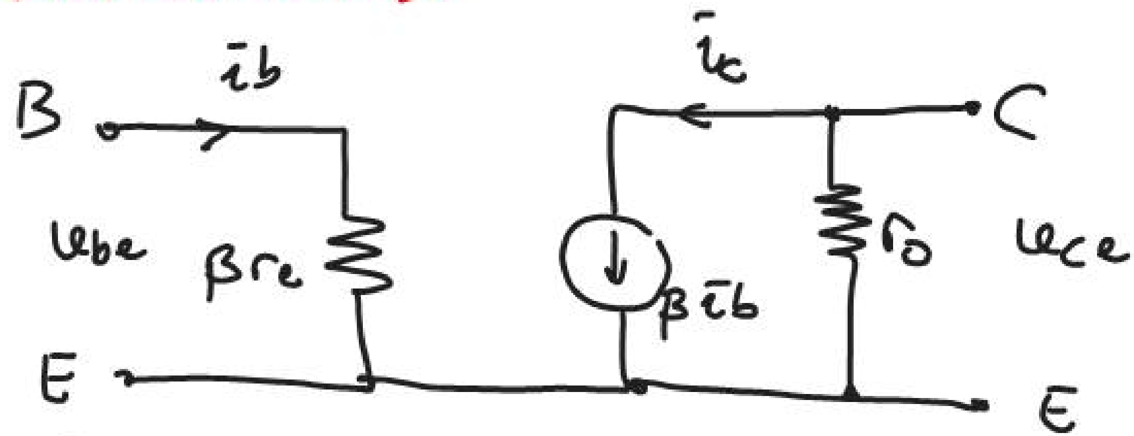
ECE 246 12.05.2012

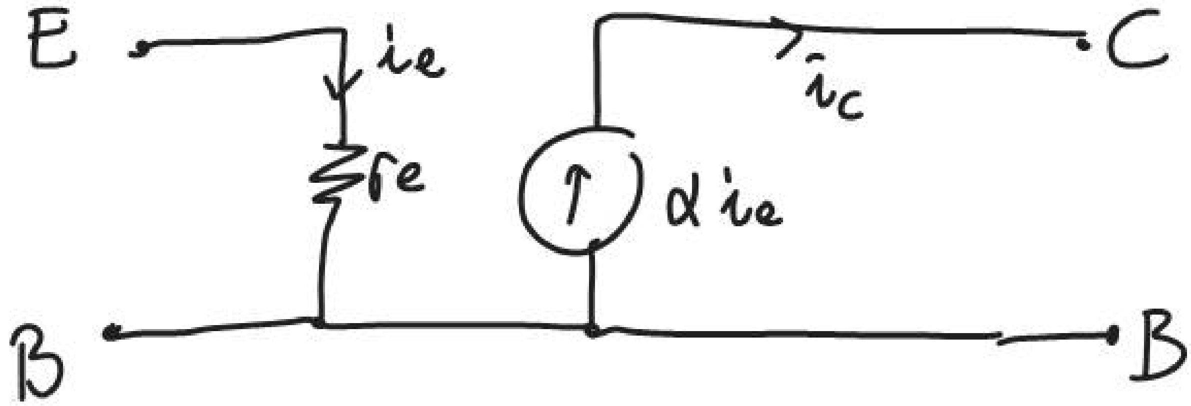
BIPOLAR JUNCTION TRANSISTOR (BJT)

AMPLIFIERS

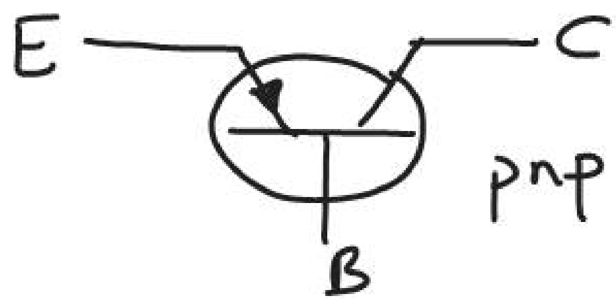


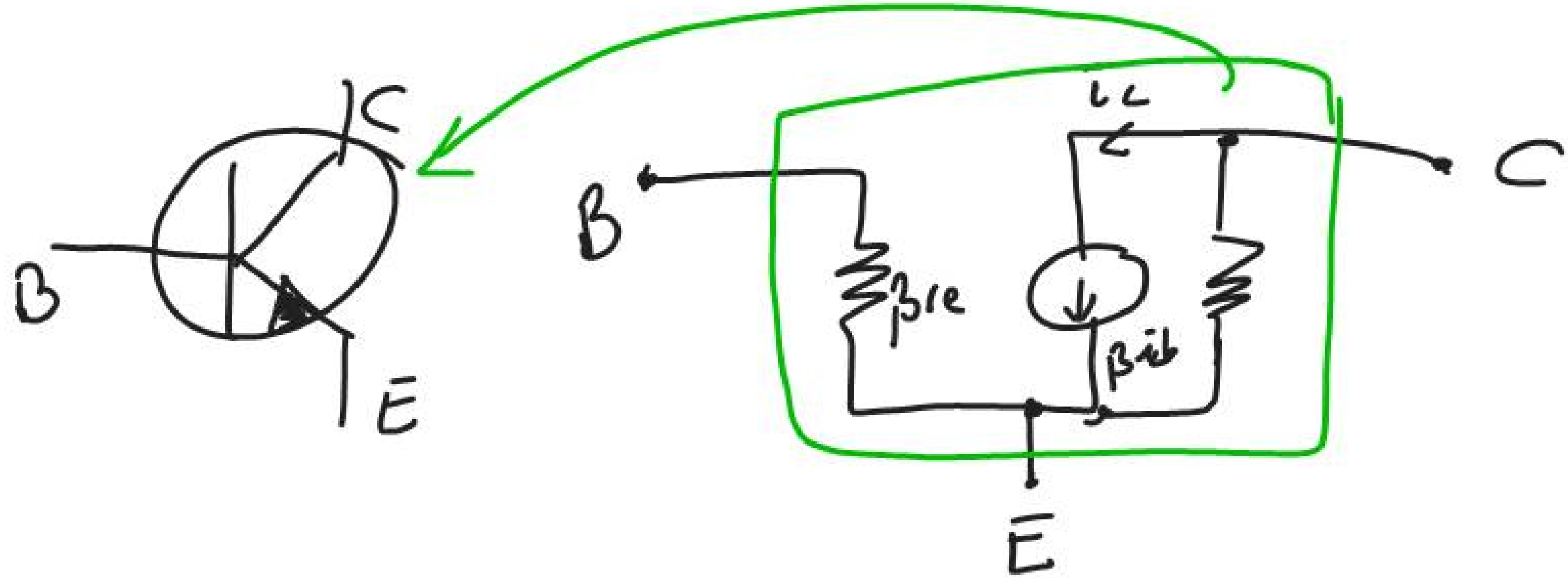


Common Emitter (CE) BJT equivalent circuit for ac signals (small signals) (we use the same for CC configuration as well)



Common base (CB) equivalent





C
B
E
B
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ic
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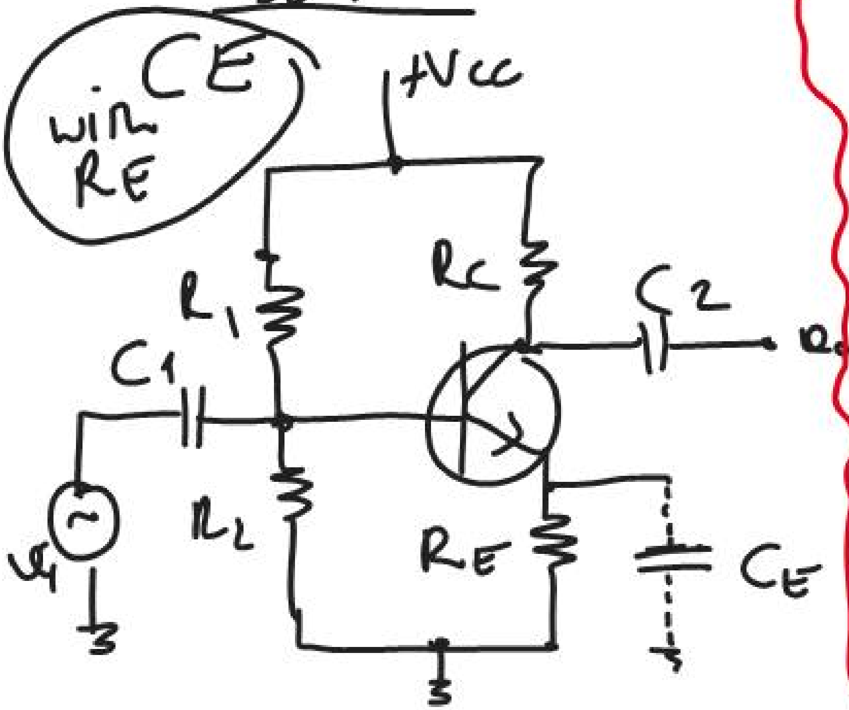
REMINDER

BJT

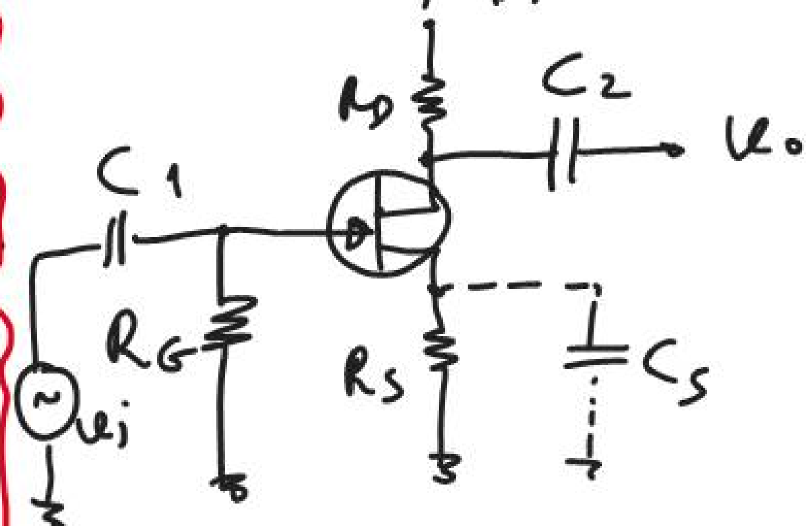


$$A_v = \frac{v_o}{v_i} = -\frac{R_C}{r_e} \quad \text{with } C_E$$

or

$$A_v = -\frac{R_C}{r_e + R_E} \quad \text{without } C_E$$

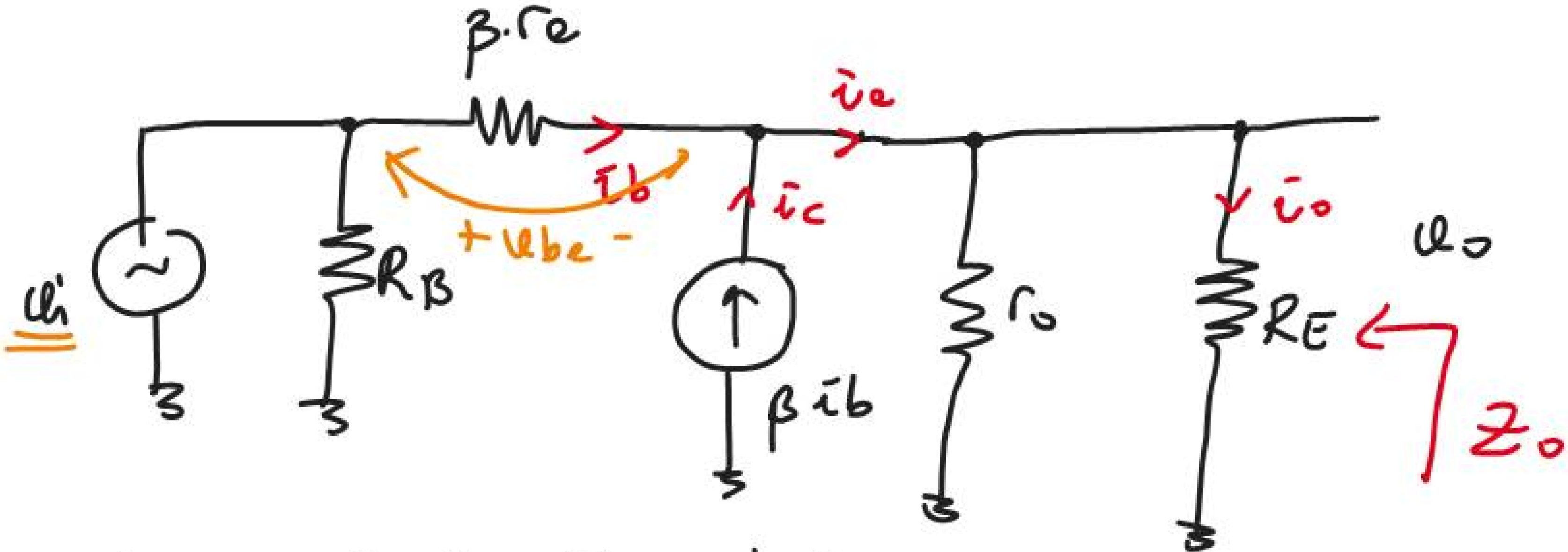
FET CS



$$A_v = -g_m R_D \quad \text{with } C_S$$

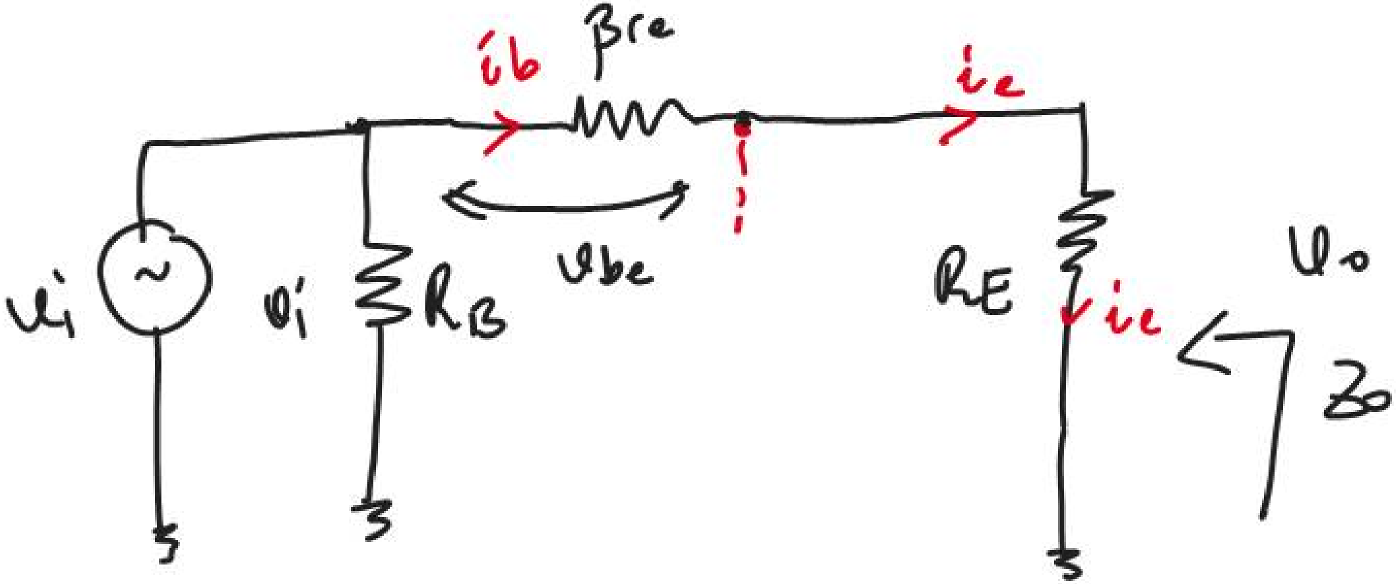
$$A_v = \frac{-g_m R_D}{1 + g_m R_S} \quad \text{without } C_S$$

Calculating Z_o in CC (Emitter Follower)

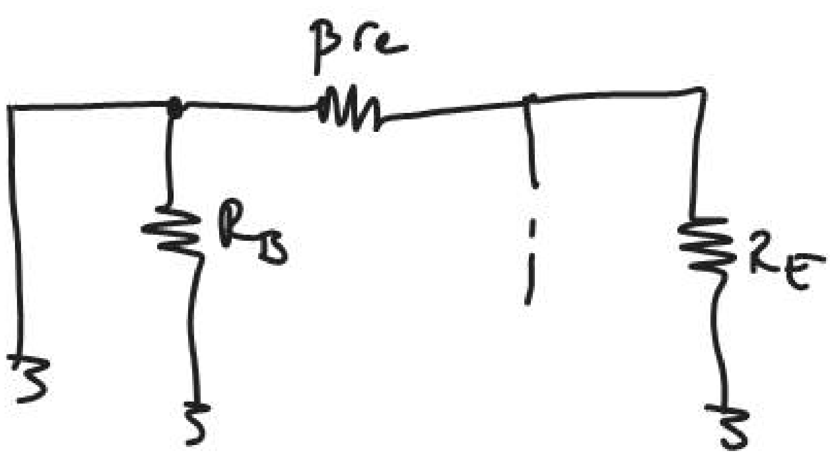


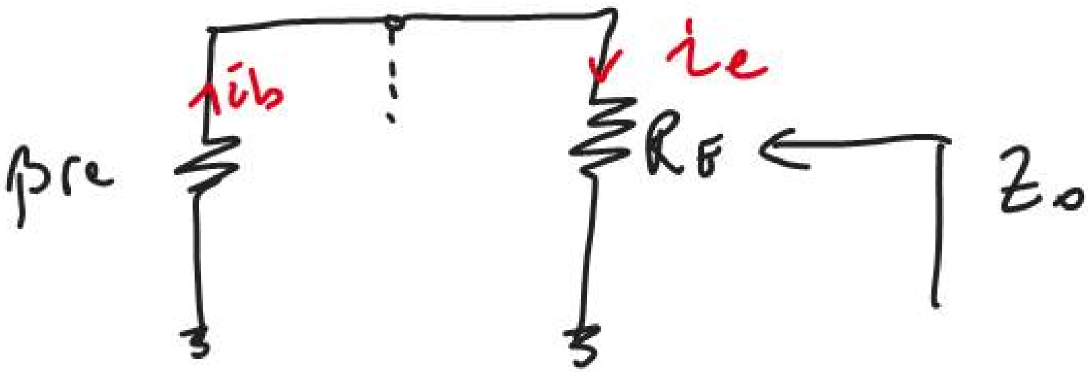
If we neglect r_o and the equivalent resistance of the current source in comparison with R_E as parallel:

$$Z_{\text{current source}} \parallel r_o \parallel R_E \approx R_E$$

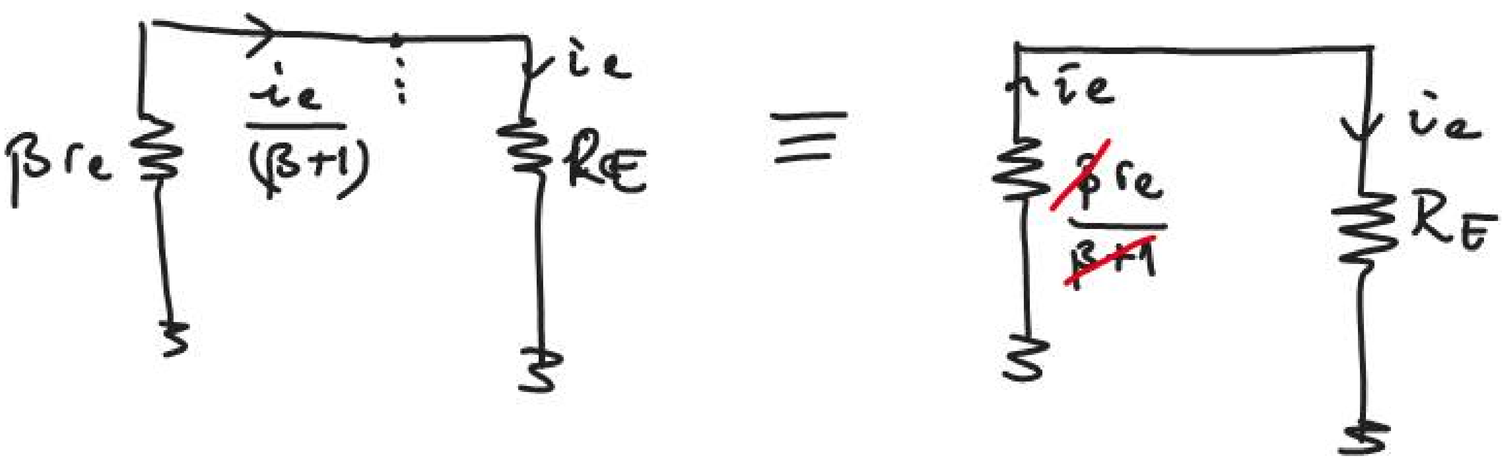


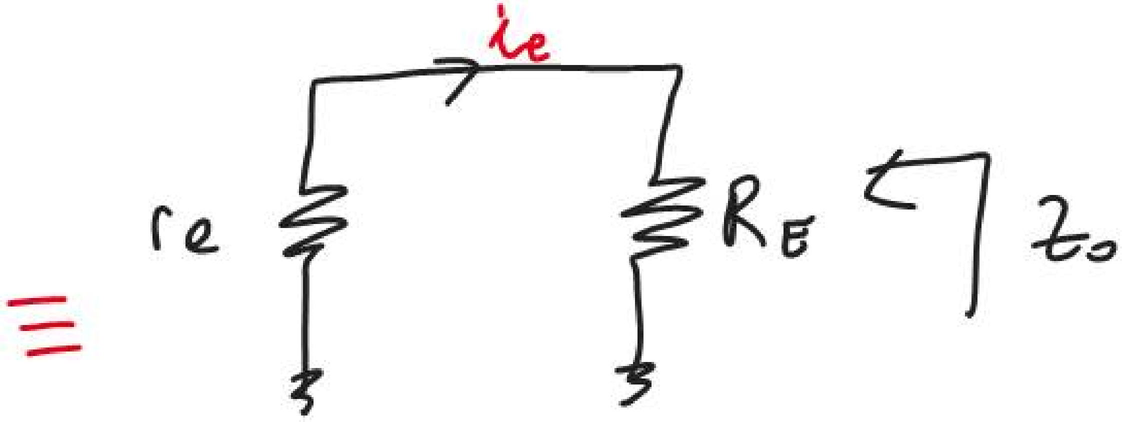
short circuit input power supply when calculating Z_o (by definition)





We equalise the current in the circuit:





$$Z_o \cong R_E // r_e$$

Calculation of A_v

$$v_i = v_{be} + v_o$$

$$= i_b \cdot \beta \cdot r_e + i_o \cdot R_E \qquad i_o \approx i_e$$

$$v_i \cong i_b \cdot \beta \cdot r_e + i_e \cdot R_E$$

$$v_i = \beta \cdot i_b \cdot r_e + (\beta+1)\, i_b \cdot R_E \qquad \beta \cong \beta + 1$$

$$v_i = \beta\, i_b\,(r_e + R_E) \Rightarrow i_b = \frac{v_i}{(r_e+R_E)\beta}$$

$$v_o \cong i_e \cdot R_E$$

$$= \beta \cdot i_b \cdot R_E$$

$$v_o = \beta \left(\frac{v_i}{r_e+R_E}\right)\frac{1}{\beta} \cdot R_E$$

$$\boxed{\frac{v_o}{v_i} = A_v = \frac{R_E}{r_e+R_E}}$$

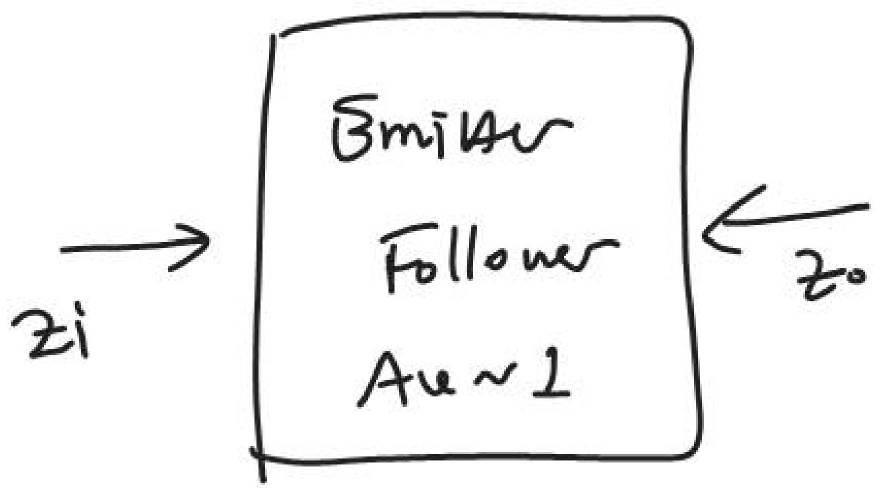
$$A_v = \frac{R_E}{r_e + R_E}$$ Voltage Gain of Emitter Follower Circuit

- $A_v < 1$
- output voltage is in the same phase ($\theta = 0°$) with input voltage

$Z_i \cong R_B // [\beta (r_e + R_E)]$ very high input impedance

$Z_o \cong r_e // R_E \approx r_e$ very low output impedance

Emitter follower circuit can be used as an IMPEDANCE MATCHING CIRCUIT



$$Z_i \cong R_B \,//\, \beta(r_e + R_E)$$

$$Z_o \cong r_e$$