BJT Topologies - Analysis (H.3)

20170609-2

References

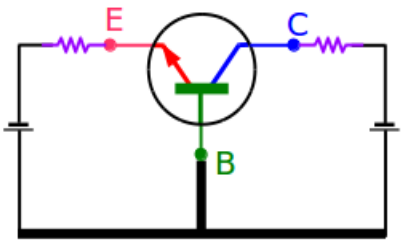
Based

[1] Floyd, Electronic Devices 7th ed
[2] Cook,

[2] en.wikipedia.org

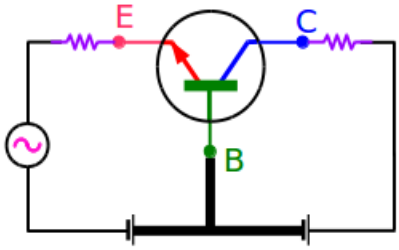
I. CB (Common Base)
II. CE (Common Emitter)
III. CC (Common Collector)

1
CB



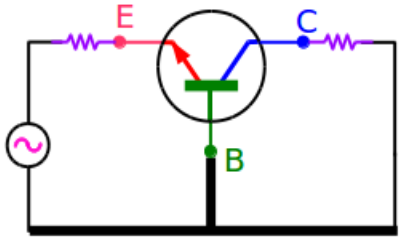
Common Base

DC Bias



Common Base

DC Bias + AC Signal

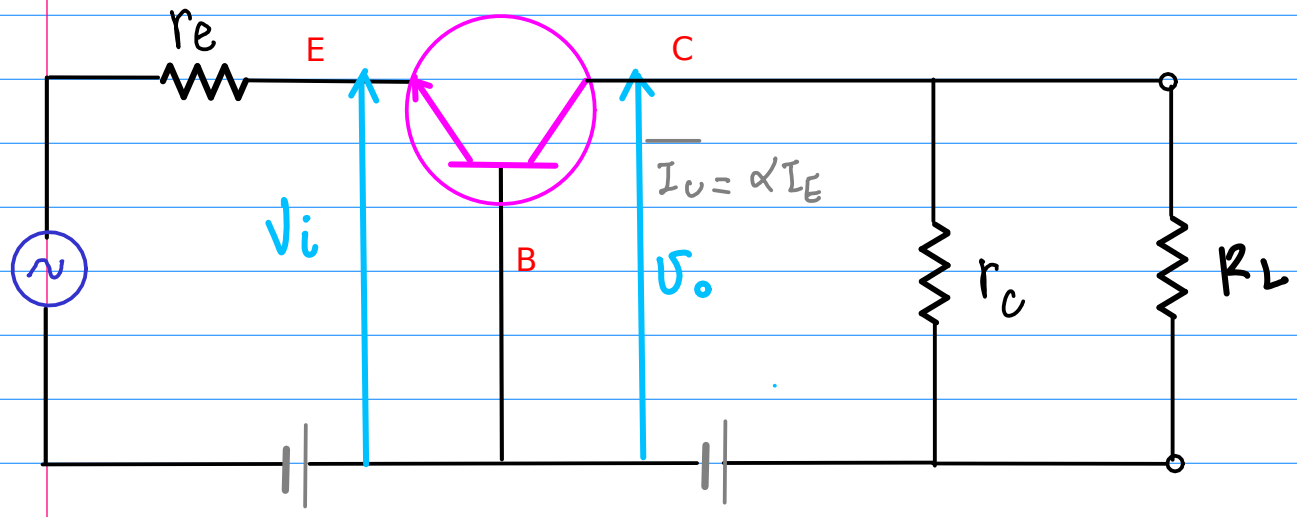


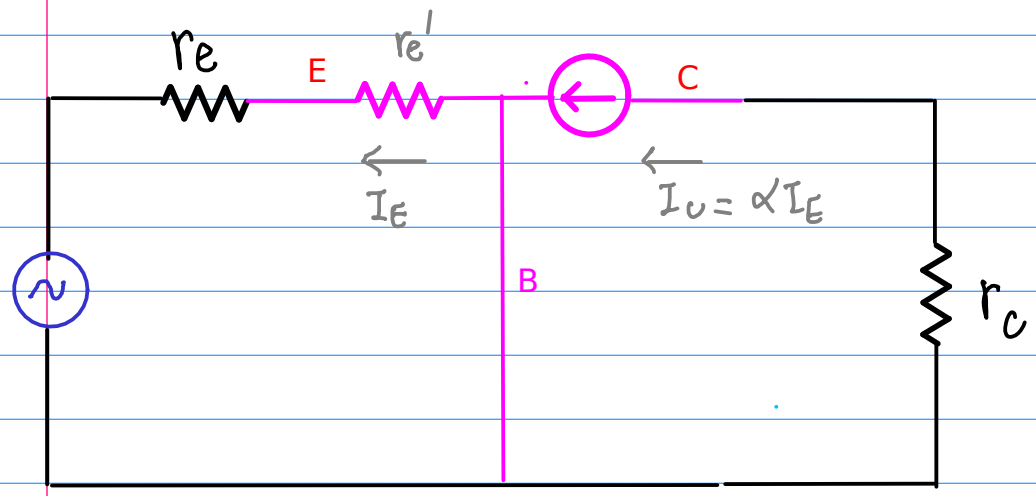
Common Base

AC Signal

(1)

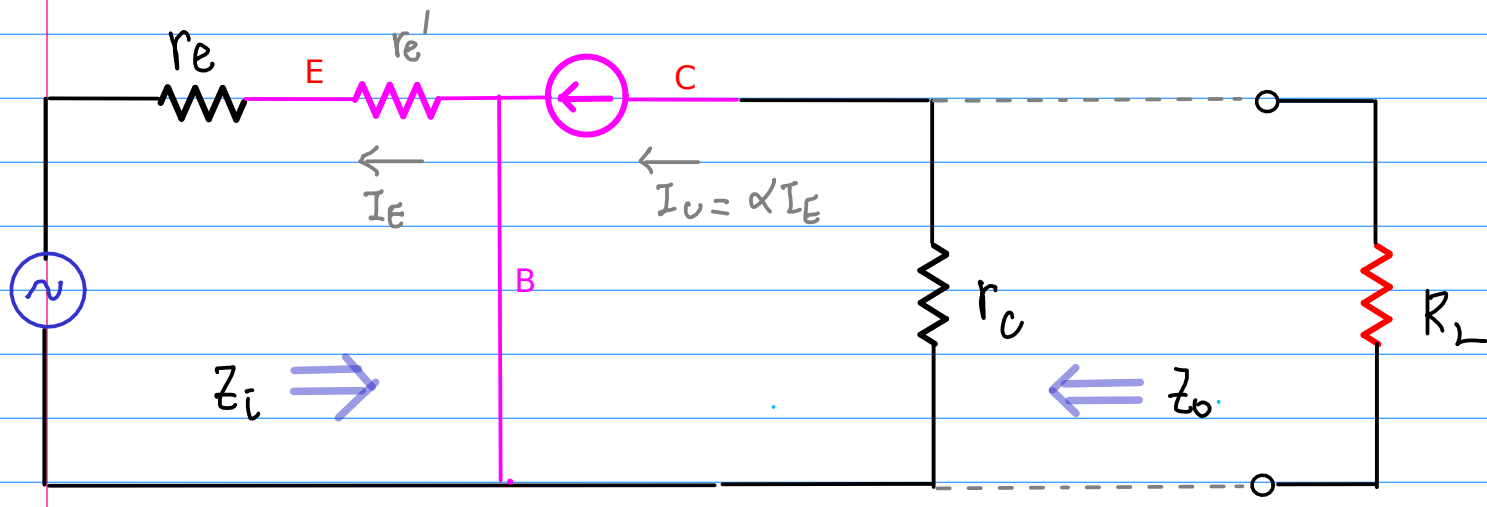
CB





I

C B



$$Z_i = r_e'$$

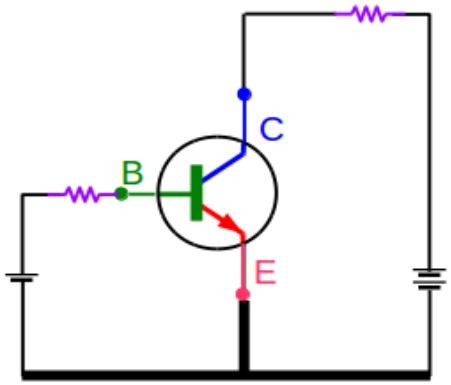
$$Z_o = r_c = \frac{V_{out\,(oc)}}{i_{out\,(sc)}} = \frac{I_c\, r_c}{I_c}$$

$$A_V = \frac{V_{out}}{V_{in}} = \frac{I_c\, r_c}{I_e \cdot r_e'} = \frac{\alpha I_e}{I_e}\,\frac{r_c}{r_e'} = \frac{r_c}{r_e'}$$

$$A_i = \frac{I_{out}}{I_{in}} = \frac{I_e}{I_c} = \alpha \approx 1$$

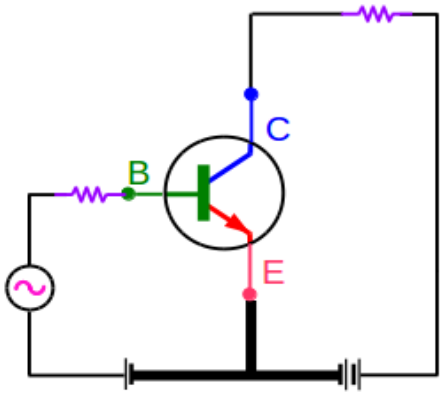
II

CE



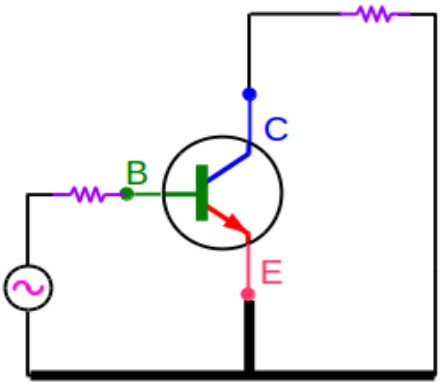
Common Emitter

DC Bias



Common Emitter

DC Bias + AC Signal

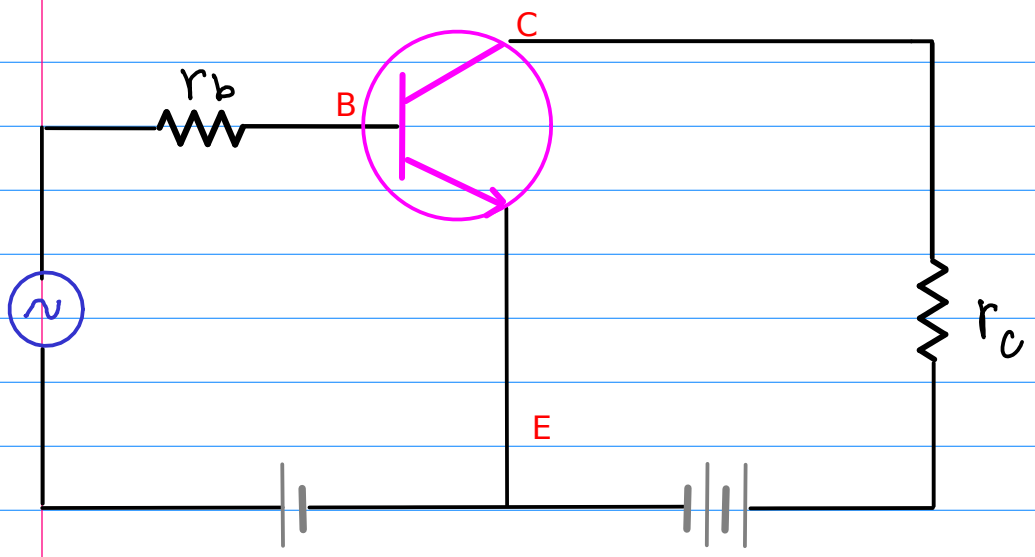


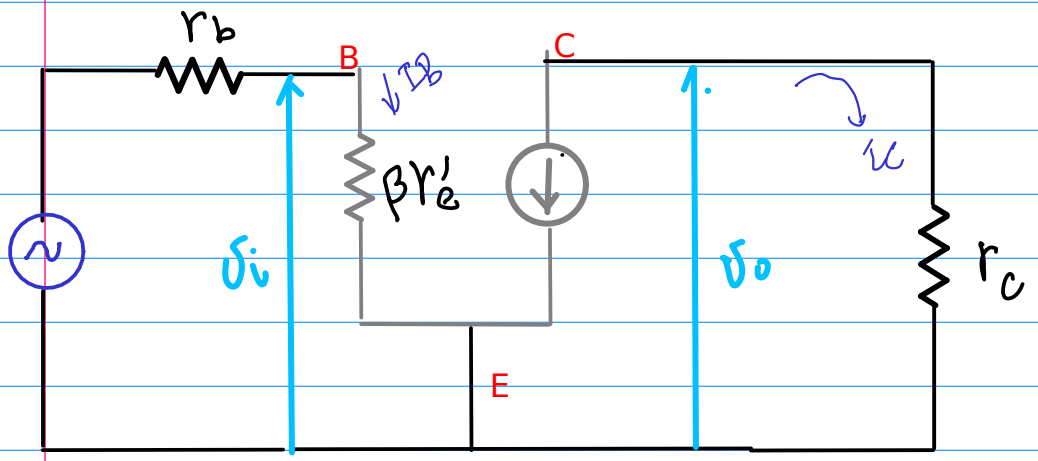
Common Emitter

AC Signal

II

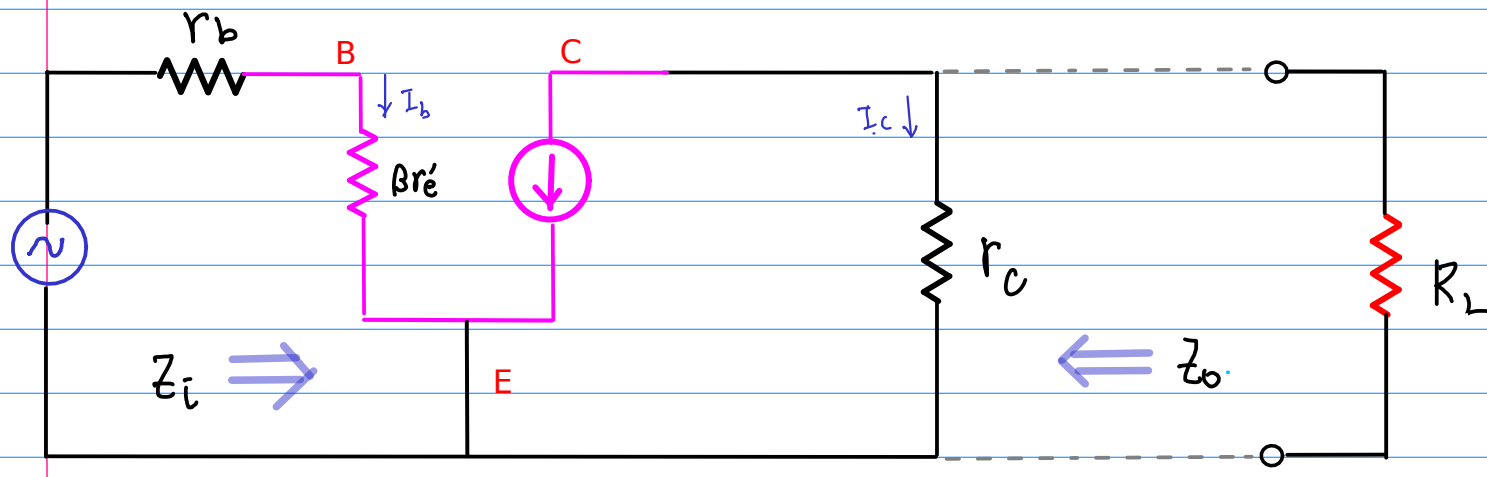
CE





II

CE



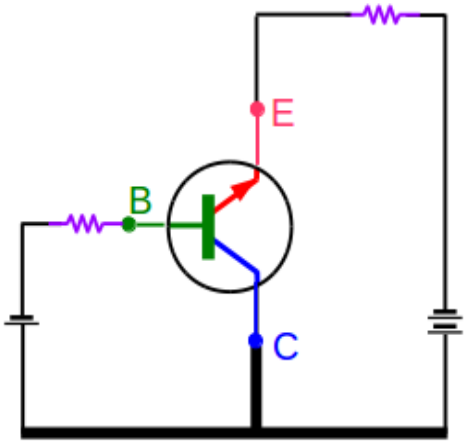
$$Z_i = \beta r_e'$$

$$Z_o = r_c = \frac{V_{out\,(oc)}}{i_{out\,(sc)}} = \frac{I_c r_c}{I_c}$$

$$A_V = \frac{V_{out}}{V_{in}} = \frac{I_c r_c}{I_b \beta r_e'} = \frac{r_c}{r_e'}$$

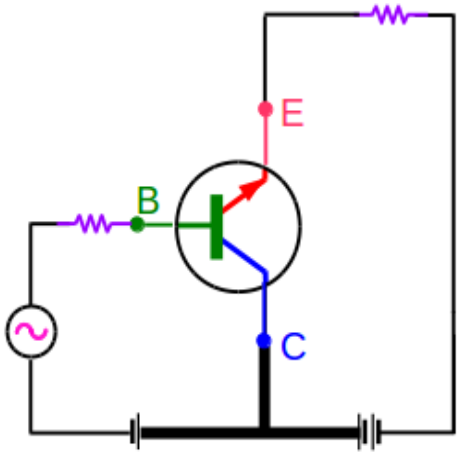
$$A_i = \frac{I_{out}}{I_{in}} = \frac{I_c}{I_b} = \beta$$

CC



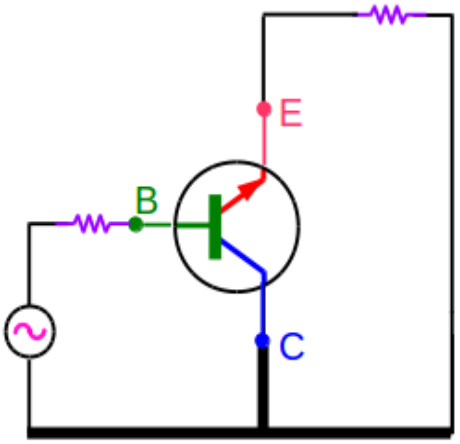
Common Collector

DC Bias



Common Collector

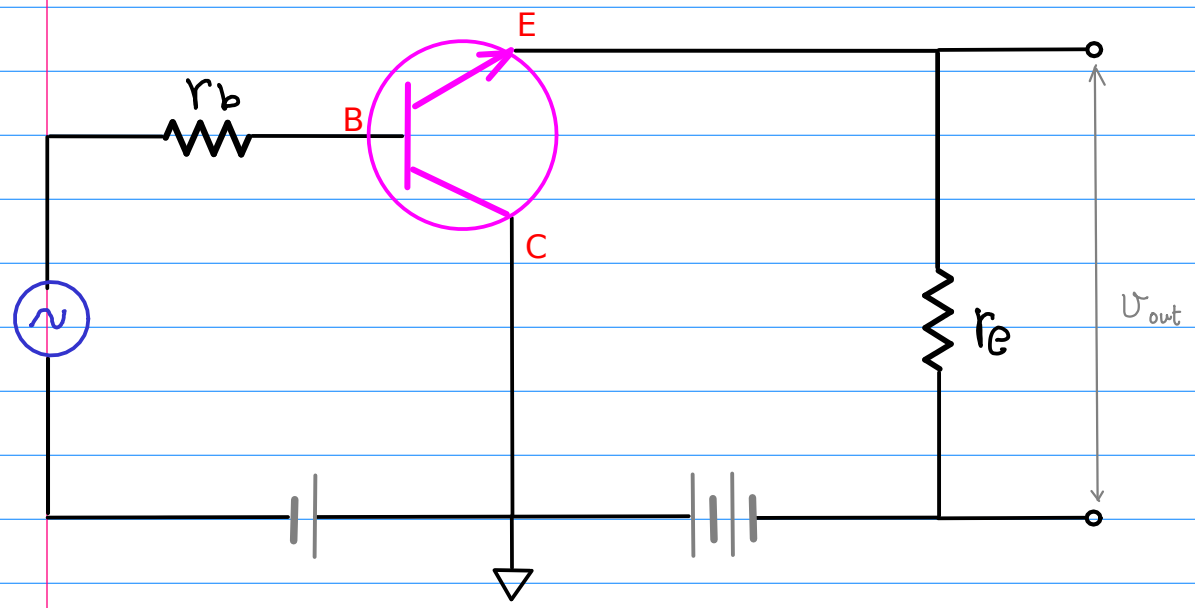
DC Bias + AC Signal

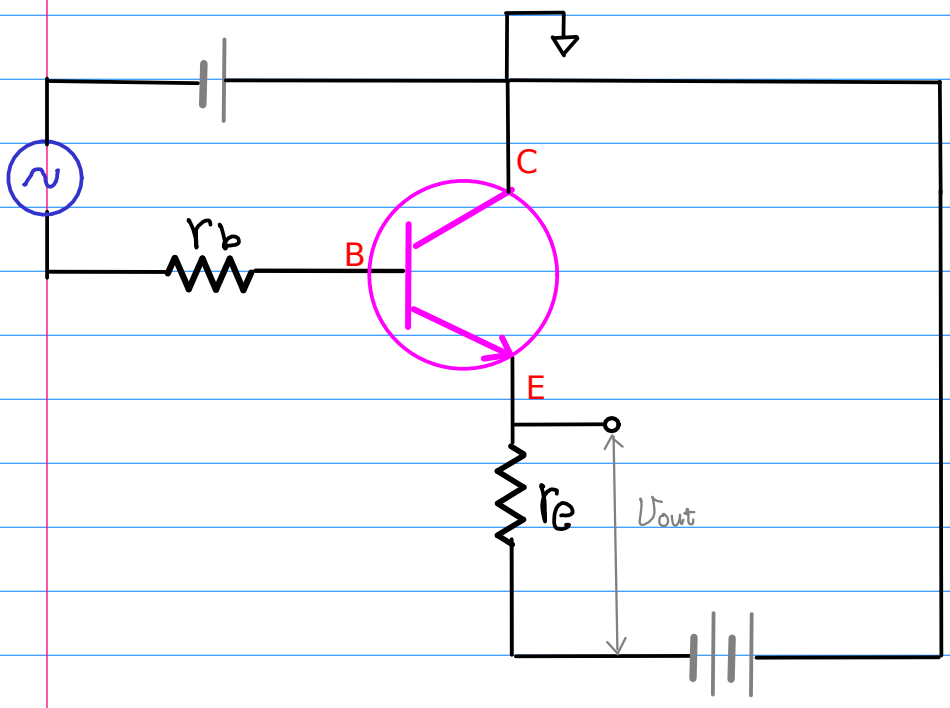


Common Collector

AC Signal

CC





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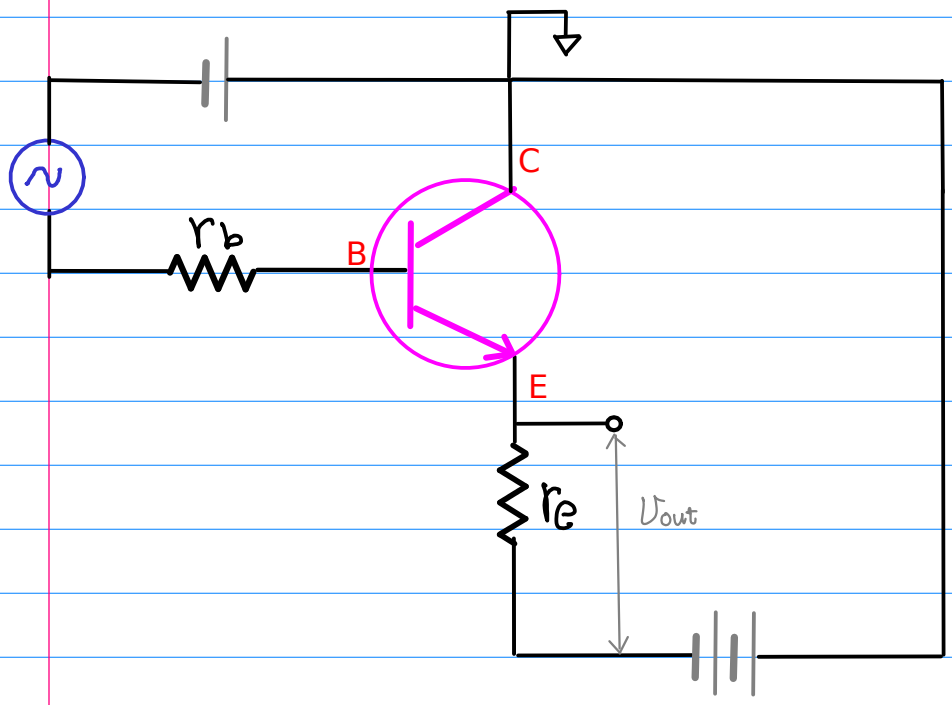
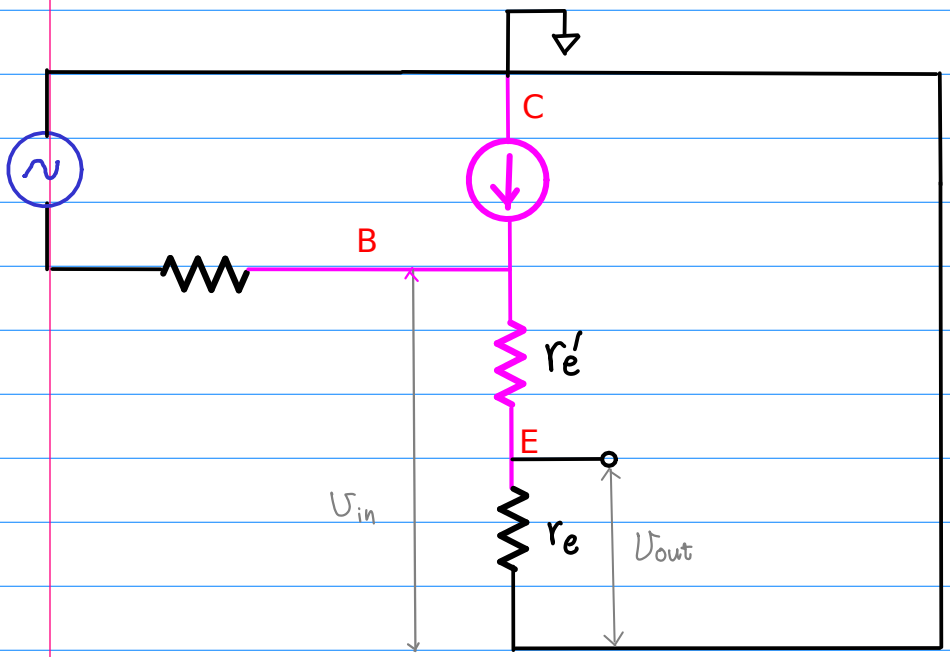
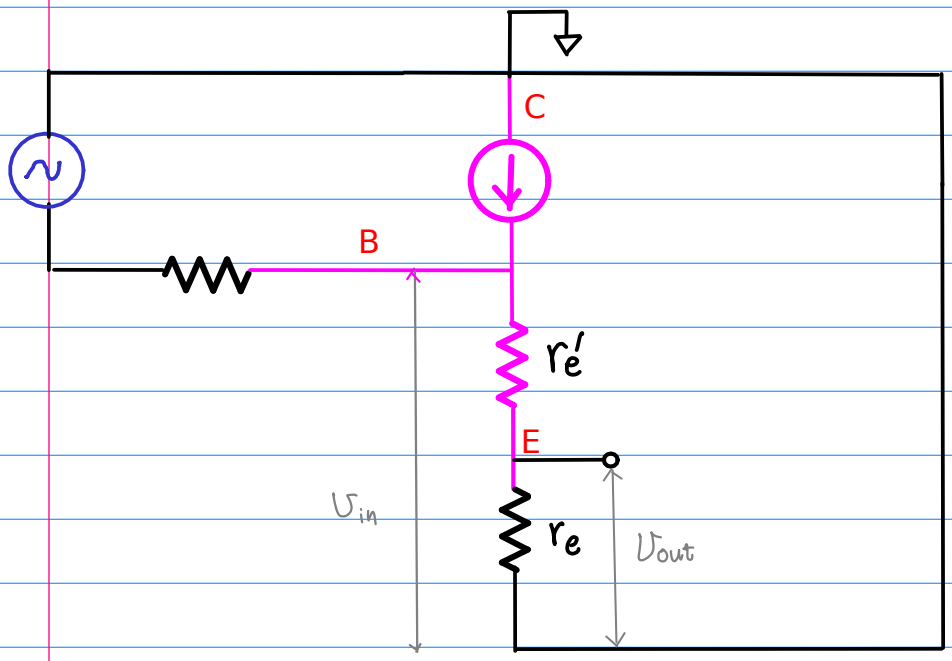




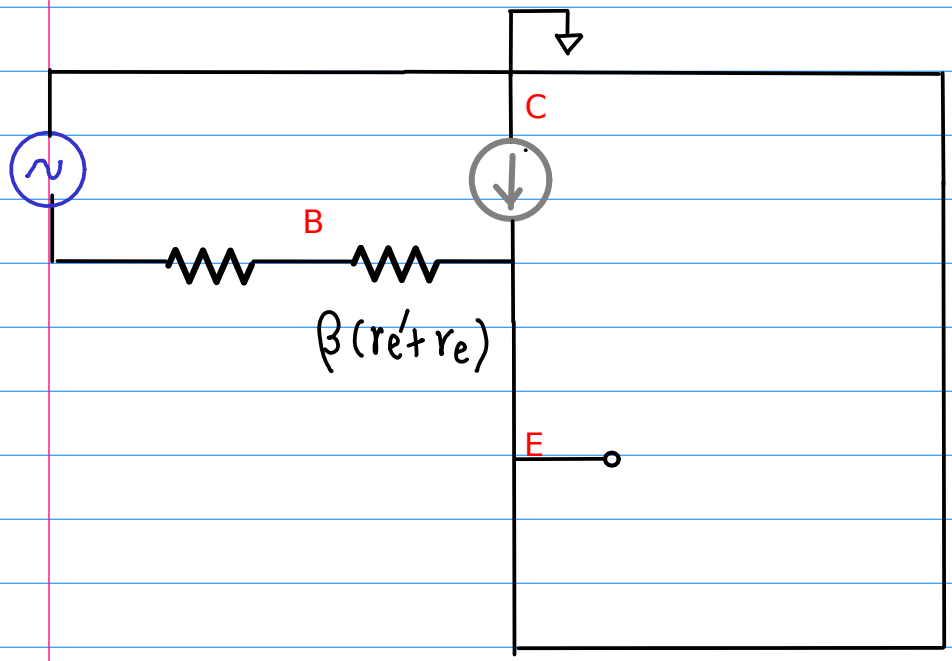
CC

Z_i



$$V_{in} = (r_e' + r_e) I_e$$
$$= (\beta+1)(r_e' + r_e) I_b$$

$$Z_i = \frac{V_{in}}{I_b}$$
$$= (\beta+1)(r_e' + r_e)$$
$$\approx \beta (r_e' + r_e)$$

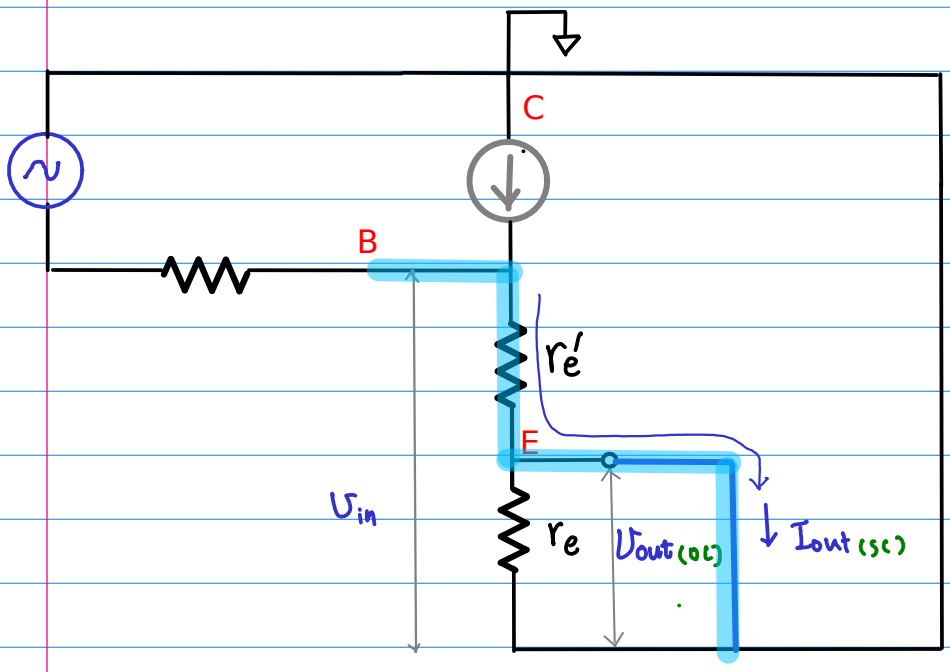


Z_i with respect to I_b

$\Rightarrow$ move r_e & r_e' to base

CC

Z_o



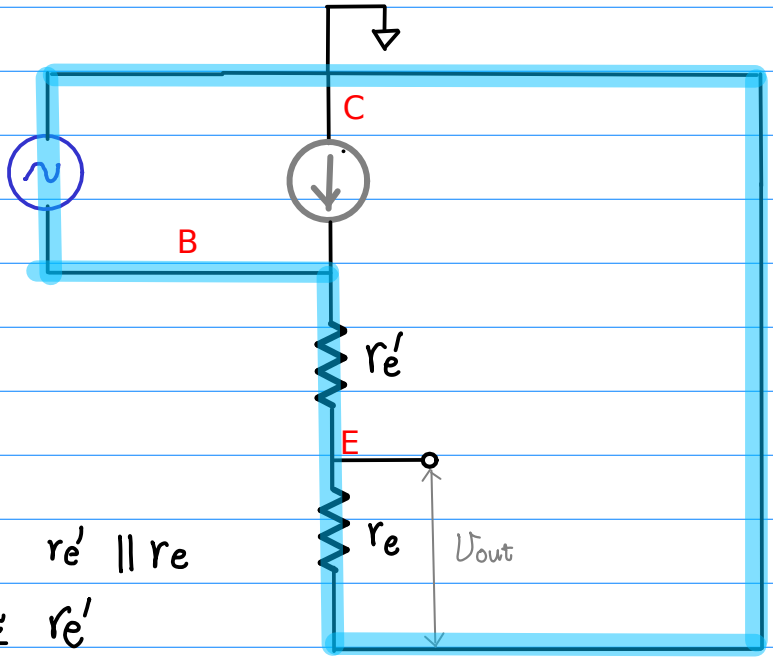
$r_e' \ll r_e$

$V_{in} \simeq V_{out(OL)}$ $\quad (r_e' + r_e) : r_e \cong 1:1$

$= r_e' \cdot I_{out(SC)}$

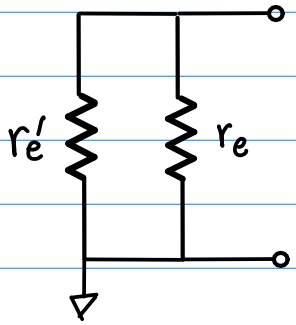
$$\boxed{Z_o = \frac{V_{out(OL)}}{I_{out(SC)}} = r_e'}$$

CC



$Z_{o(base)} = r_e' \parallel r_e$

$\cong r_e'$

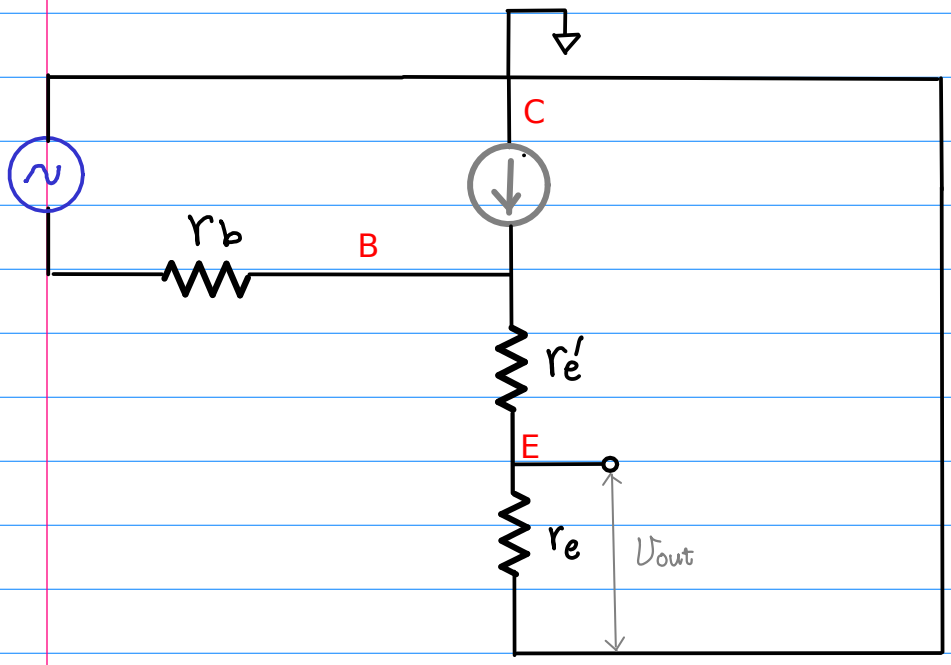


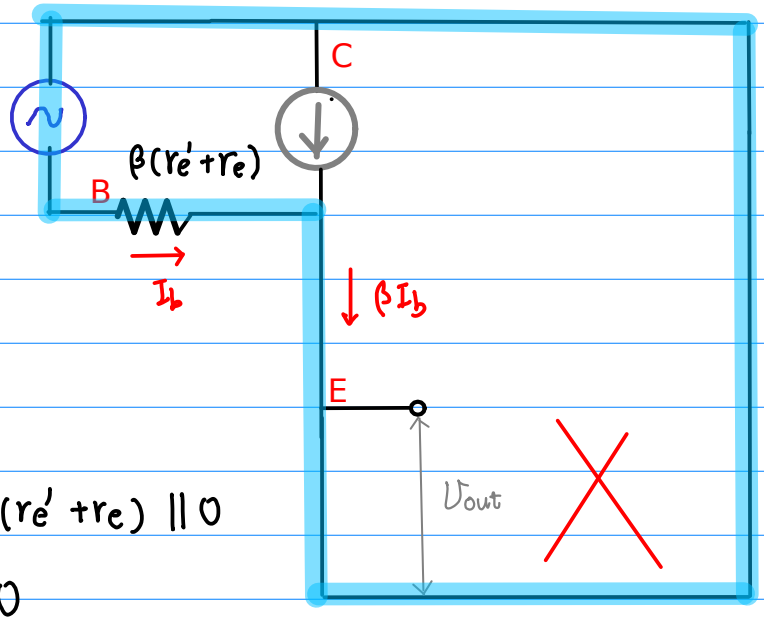
Z_o with respect to I_e

$\Rightarrow$ move r_e & r_e' to emitter

CC

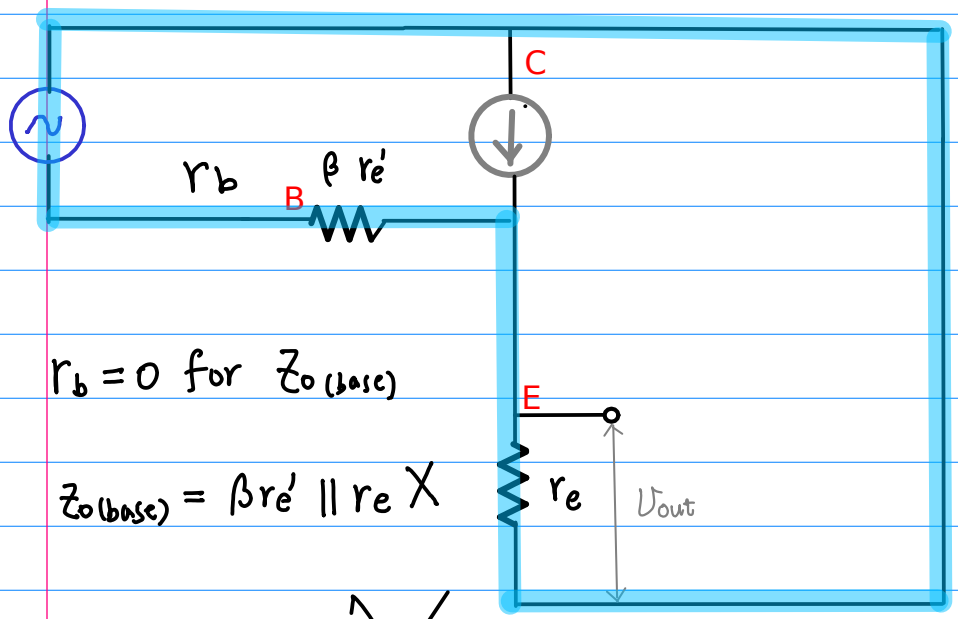
Z_o





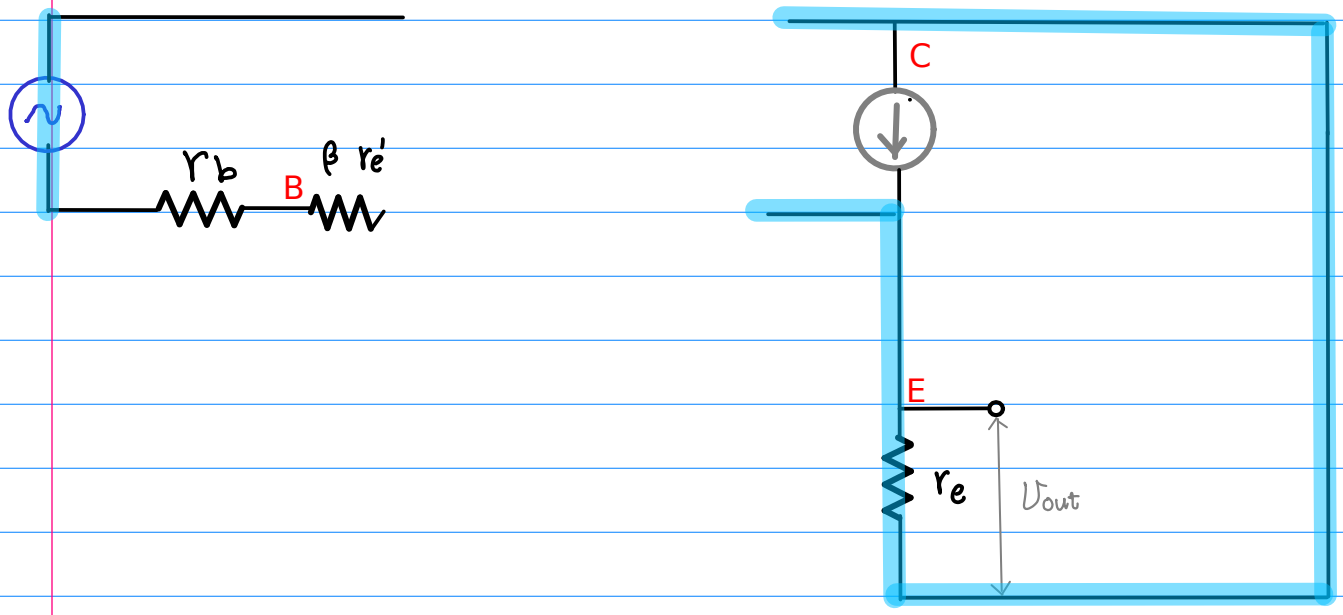
$Z_{o(base)} = \beta(r_e' + r_e) \parallel 0$

$\cong 0$

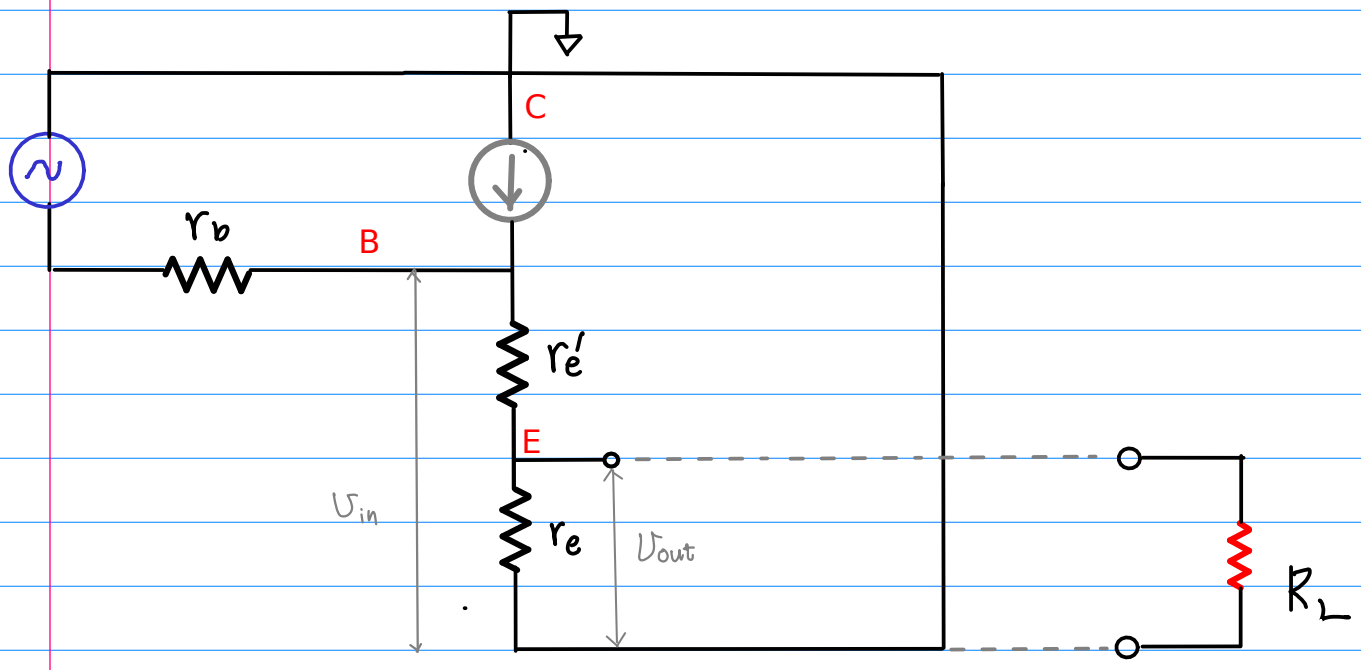


$r_b = 0$ for $Z_{o\,(base)}$

$Z_{o(base)} = \beta r_e' \,||\, r_e$ X



CC



$$Z_i = \beta (r_e' + r_e)$$

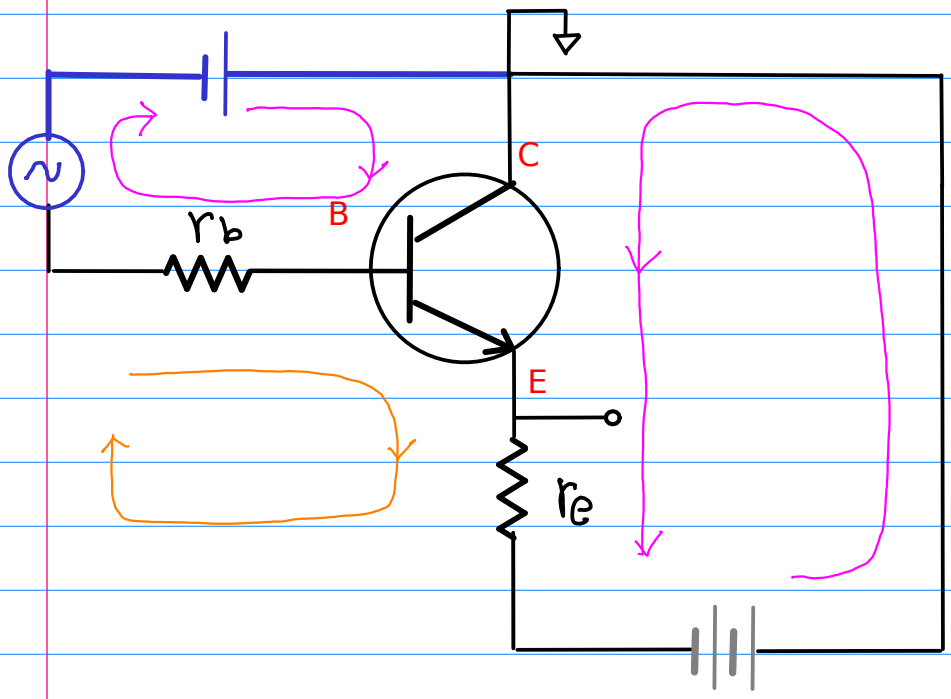
$$Z_o = r_e' = \frac{V_{out\,(oc)}}{i_{out\,(sc)}} = \frac{I_e r_e'}{I_e}$$

$$A_V = \frac{V_{out}}{V_{in}} = \frac{I_e r_e}{I_e (r_e' + r_e)} = \frac{r_e}{(r_e' + r_e)} = 1$$

$$A_i = \frac{I_{out}}{I_{in}} = \frac{I_e}{I_b} = \beta + 1 \approx \beta$$

CC

CC



CC