

BJT Topologies - Analysis (H.3)

20170609-2

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References

Based

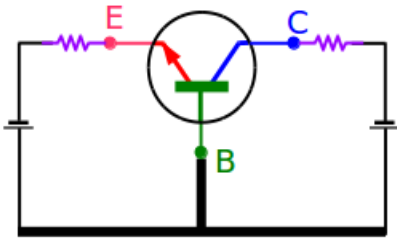
[1] Floyd, Electronic Devices 7th ed

[2] Cook,

[2] en.wikipedia.org

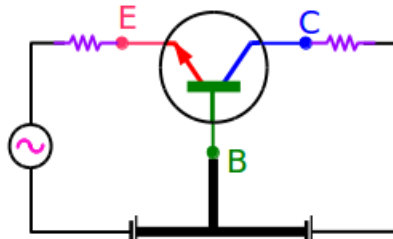
- I. CB (Common Base)
- II. CE (Common Emitter)
- III. CC (Common Collector)

CB



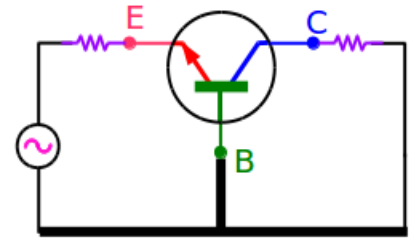
Common Base

DC Bias



Common Base

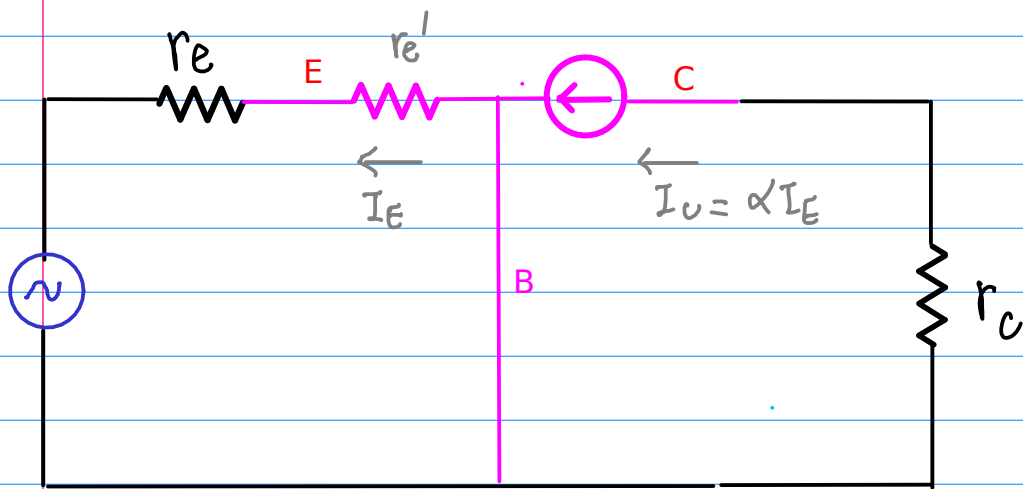
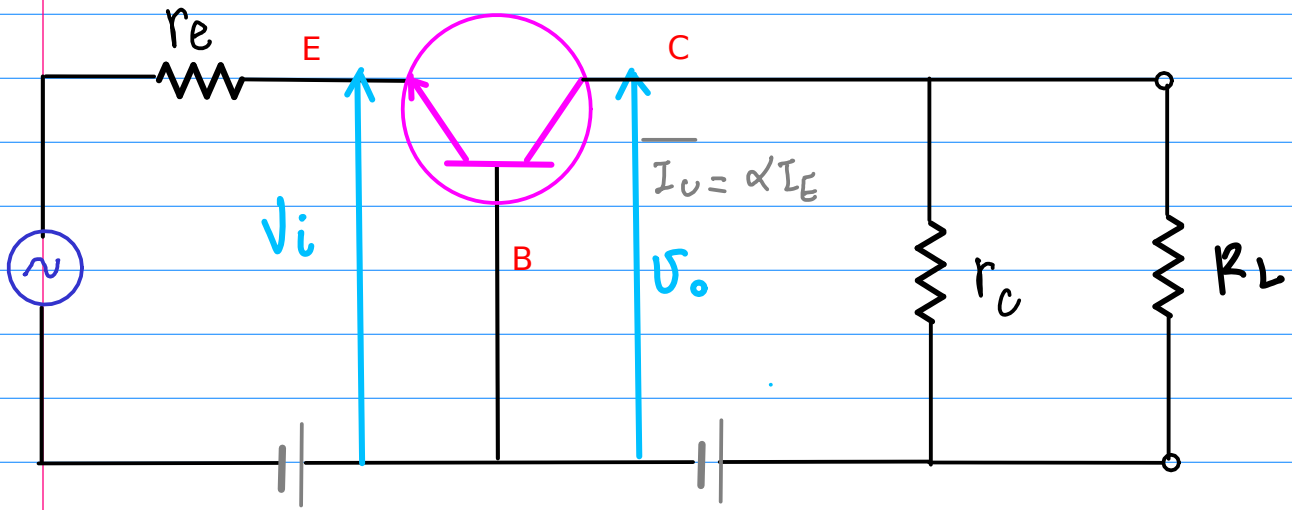
DC Bias + AC Signal



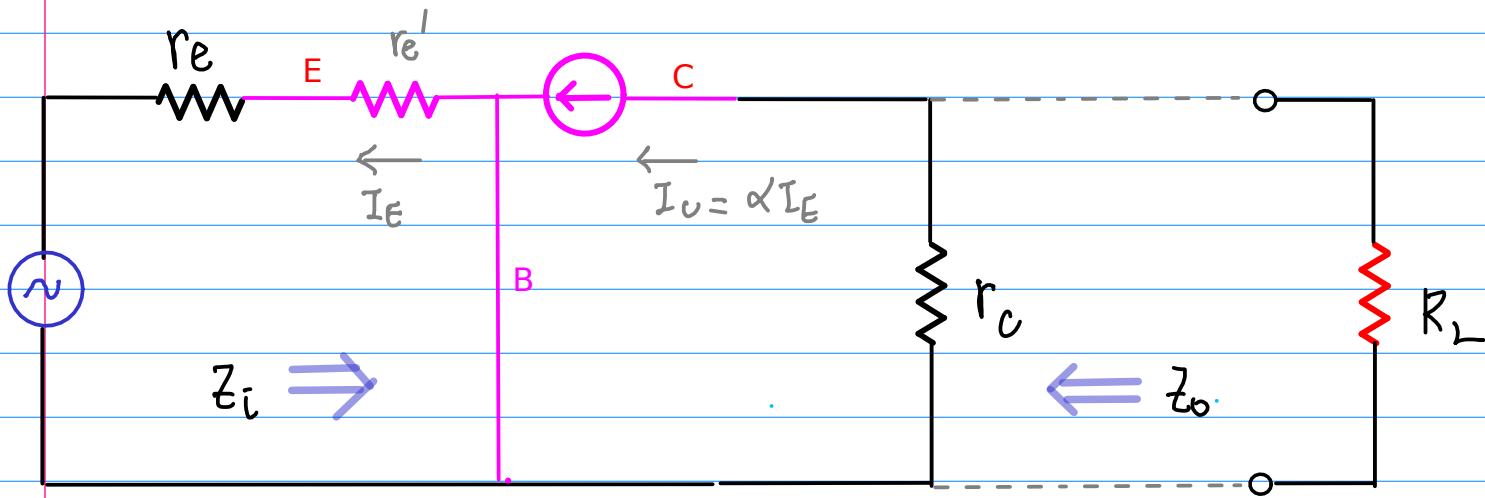
Common Base

AC Signal

I
CB



①
CB



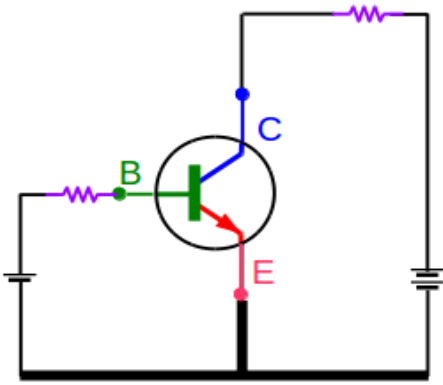
$$z_i = r_e'$$

$$z_o = r_c = \frac{V_{out}(oc)}{I_{out}(sc)} = \frac{I_c r_c}{I_c}$$

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

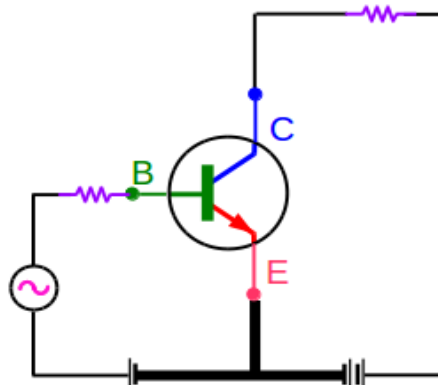
$$A_i = \frac{I_{out}}{I_{in}} = \frac{I_e}{I_c} = \alpha \approx 1$$

II
CE



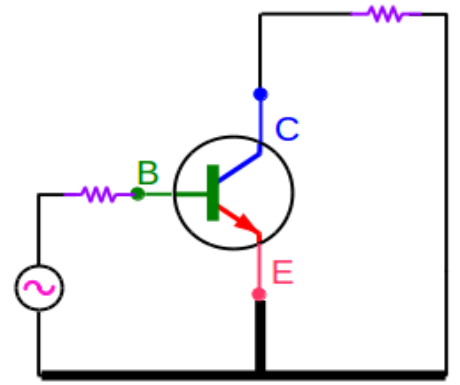
Common Emitter

DC Bias



Common Emitter

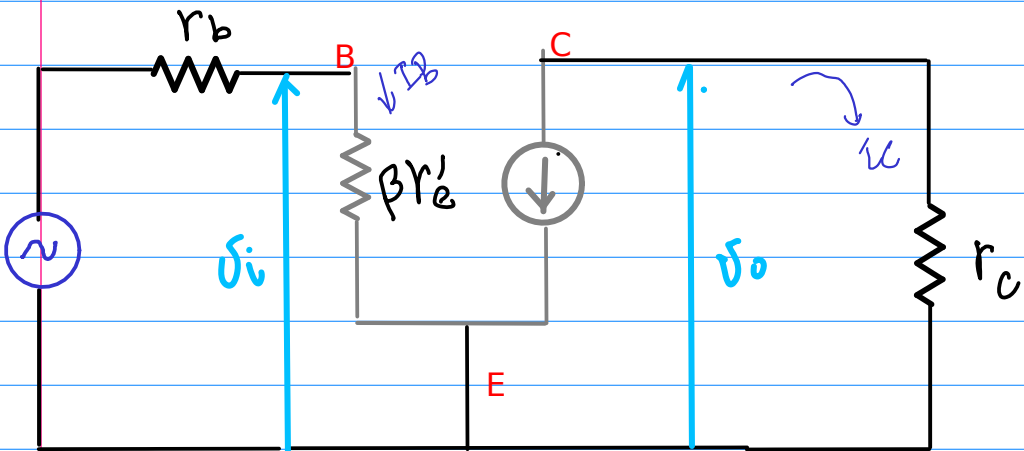
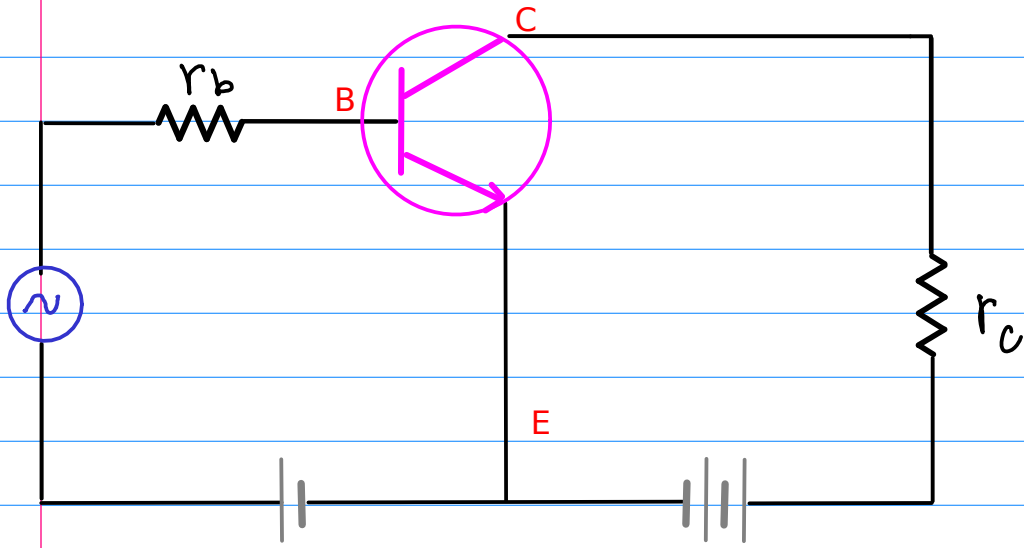
DC Bias + AC Signal



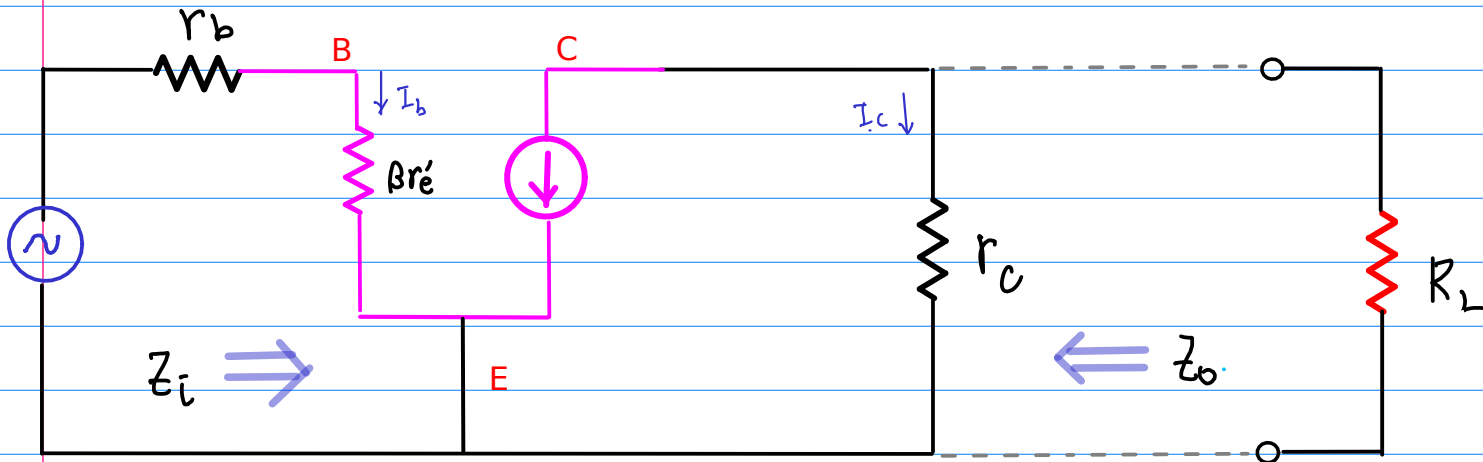
Common Emitter

AC Signal

II
CE



II
CE

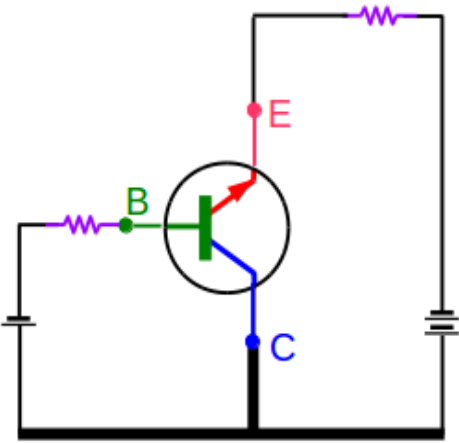


$$z_i = \beta r_e'$$

$$z_o = r_c = \frac{V_{out(oc)}}{I_{out(sc)}} = \frac{I_c r_c}{I_c}$$

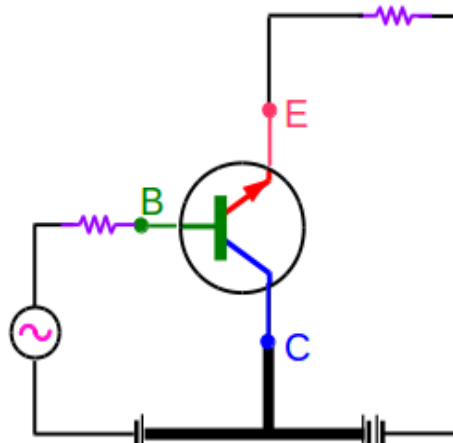
$$A_v = \frac{V_{out}}{V_{in}} = \frac{I_c r_c}{I_b \beta r_e'} = \frac{r_c}{r_e'}$$

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



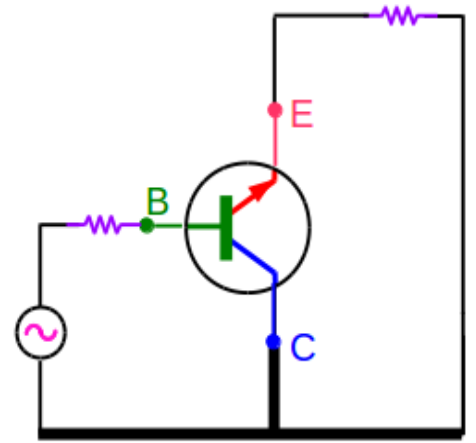
Common Collector

DC Bias



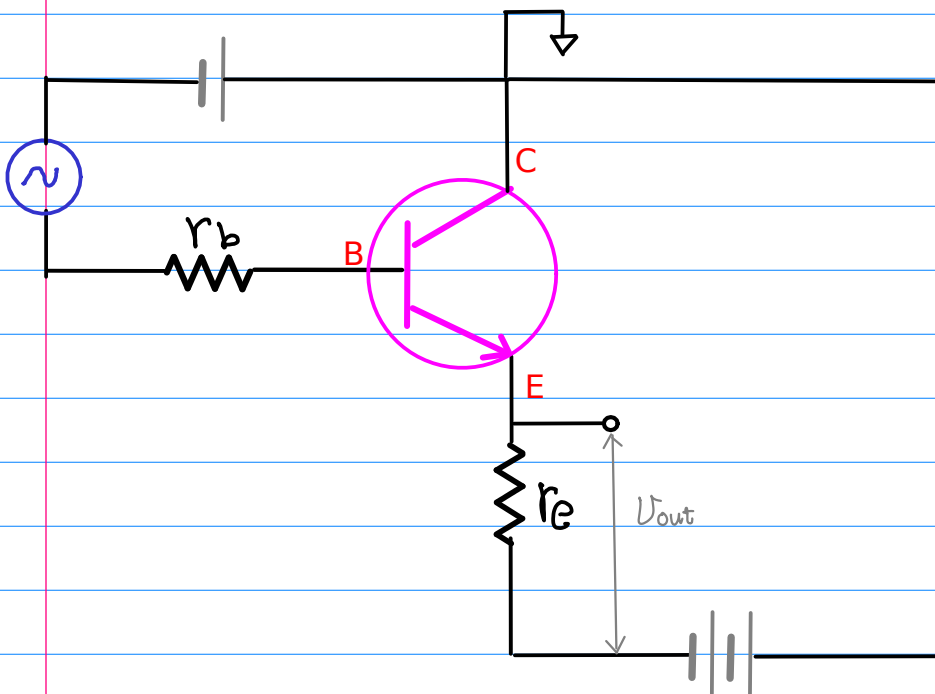
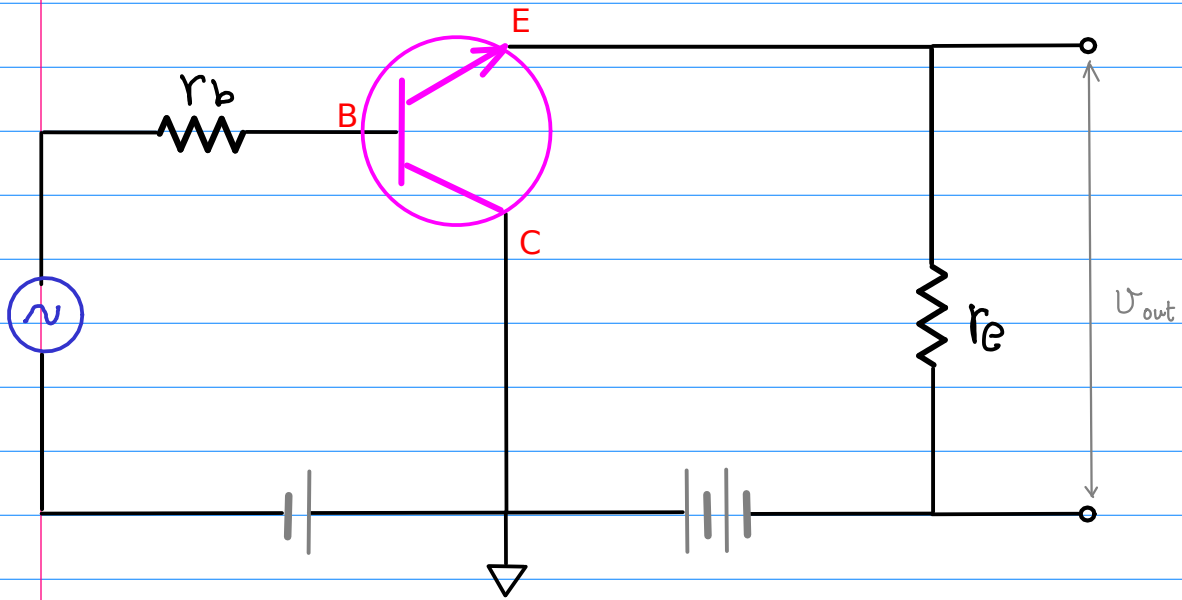
Common Collector

DC Bias + AC Signal



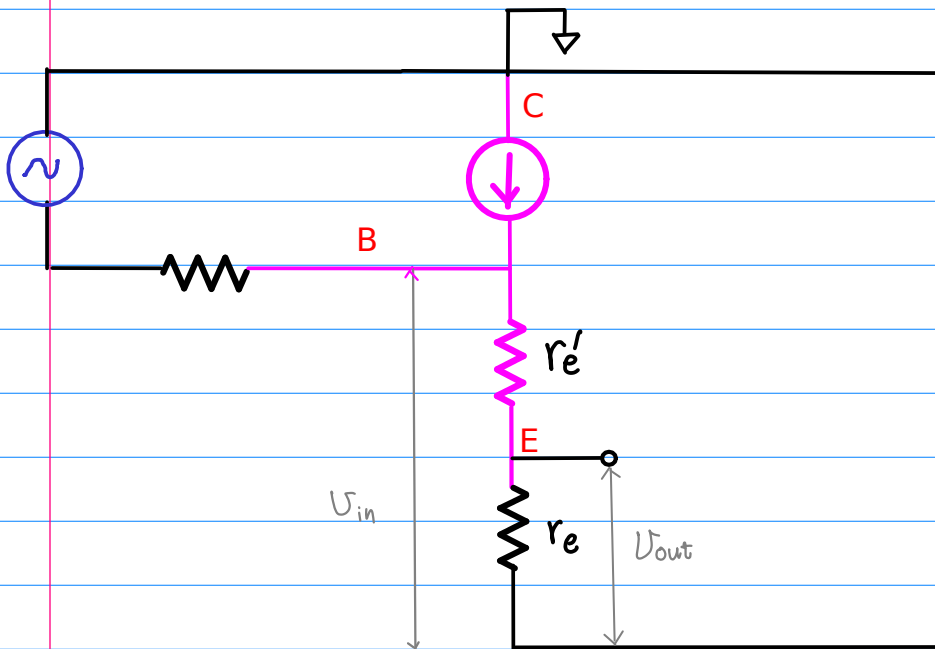
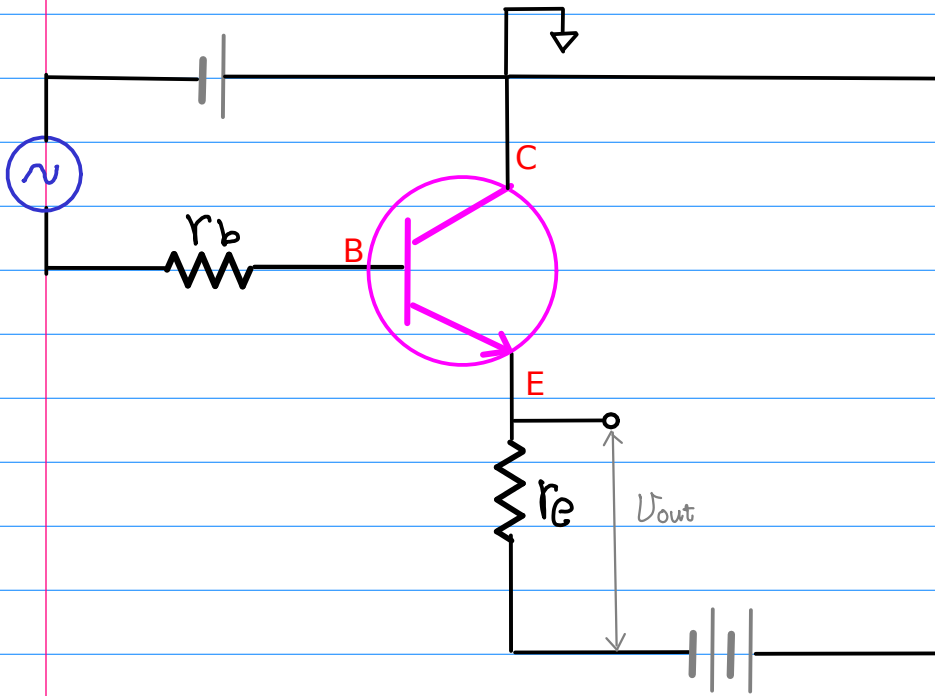
Common Collector

AC Signal



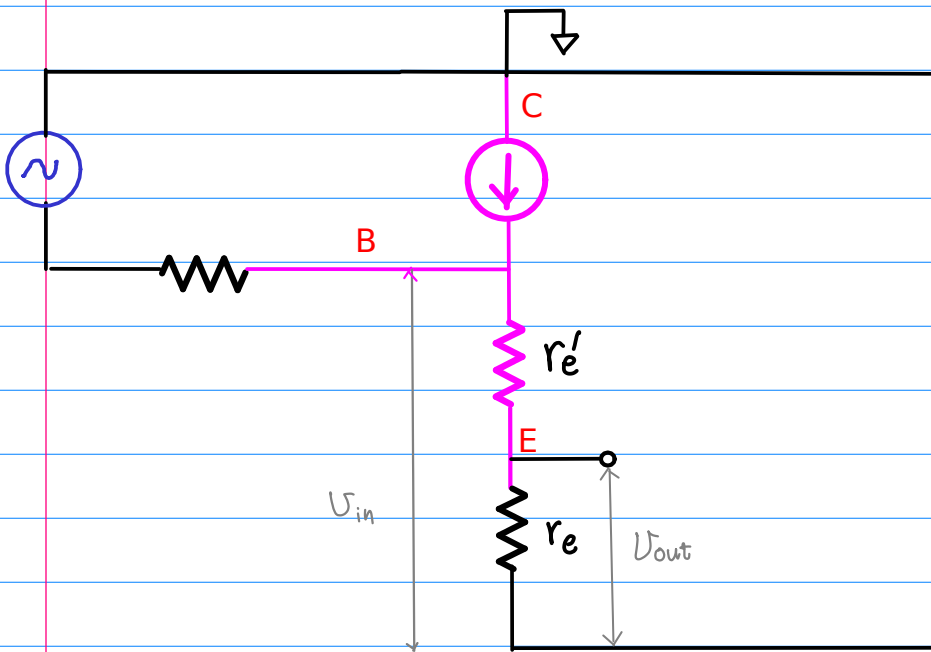


CC



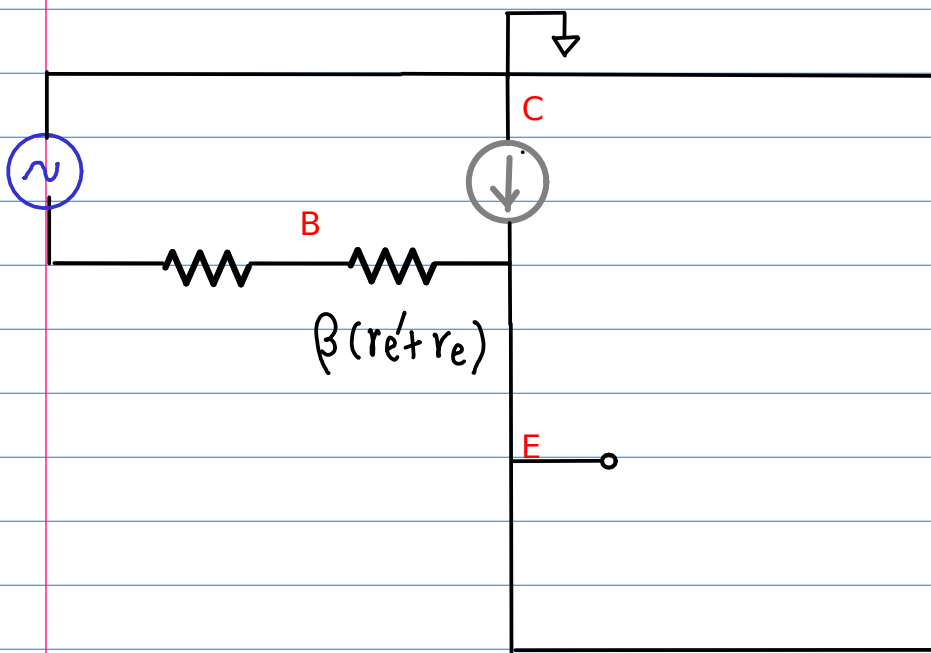


Z_i



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

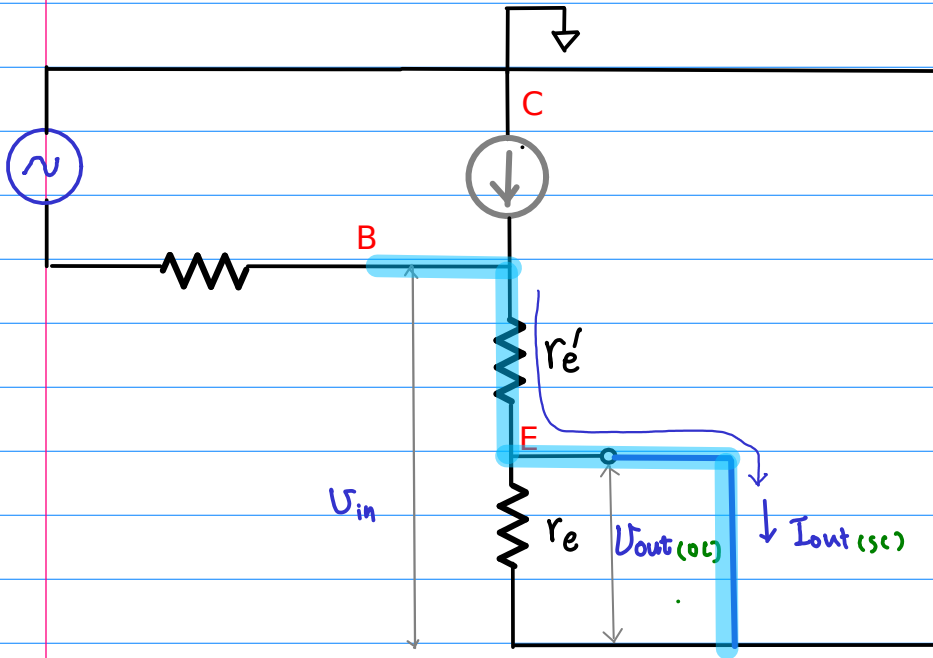
$$Z_i = \frac{V_{in}}{I_b}$$
$$= (\beta + 1)(r_e' + r_e)$$
$$\approx \beta (r_e' + r_e)$$



⊙ Z_i with respect to I_b
⇒ move r_e & r_e' to base



z_o



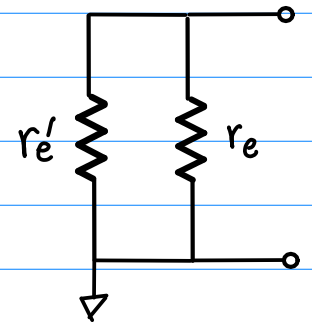
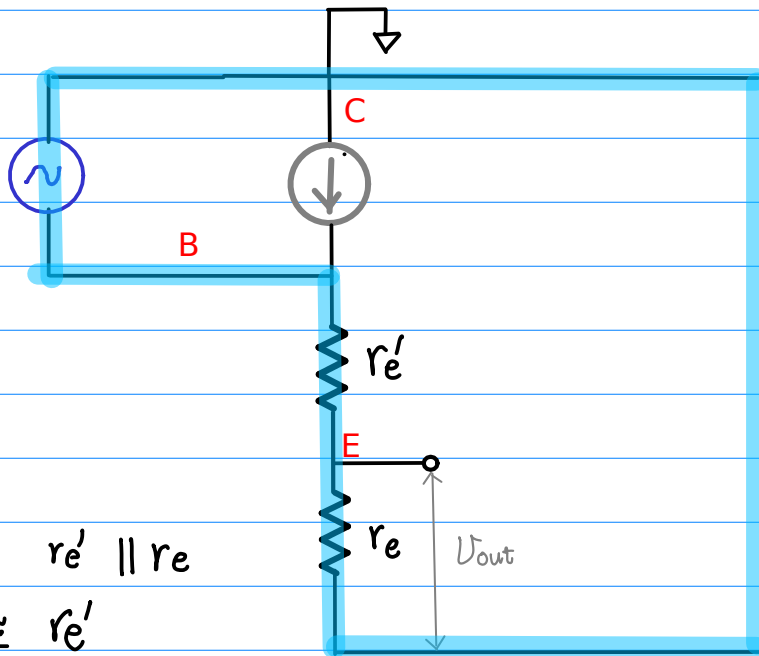
$$r_e' \ll r_e$$

$$U_{in} \approx U_{out(oc)}$$

$$(r_e' + r_e) : r_e \approx 1 : 1$$

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

$$z_o = \frac{U_{out(oc)}}{I_{out(sc)}} = r_e'$$

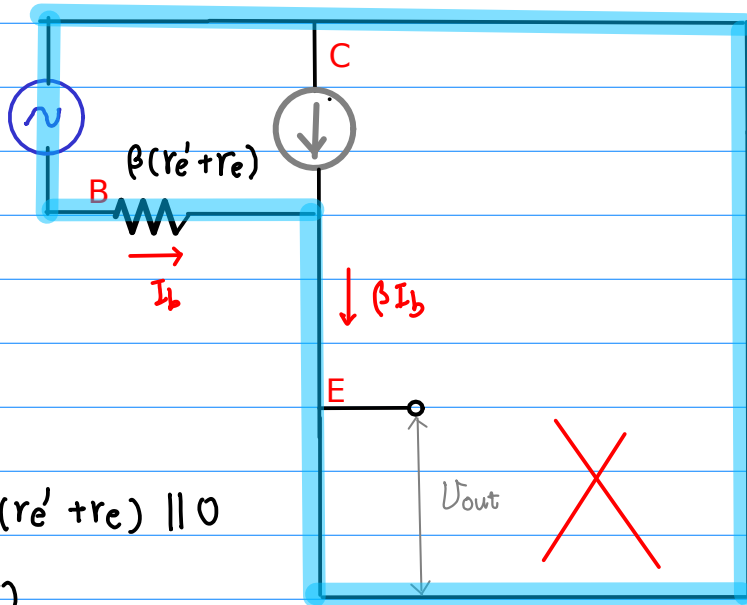
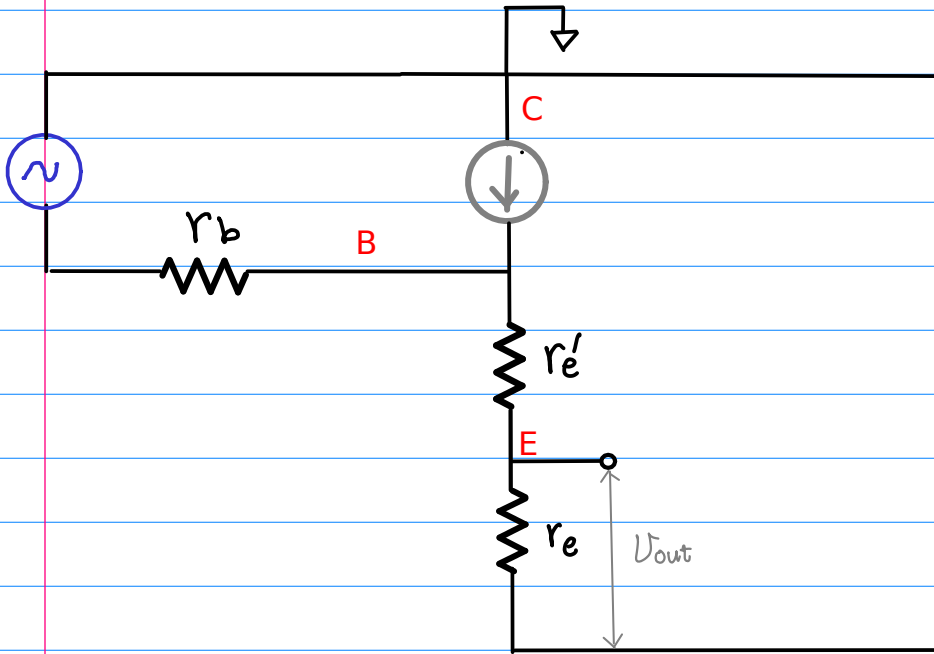


$$Z_{o(\text{base})} = r_e' \parallel r_e \\ \cong r_e'$$

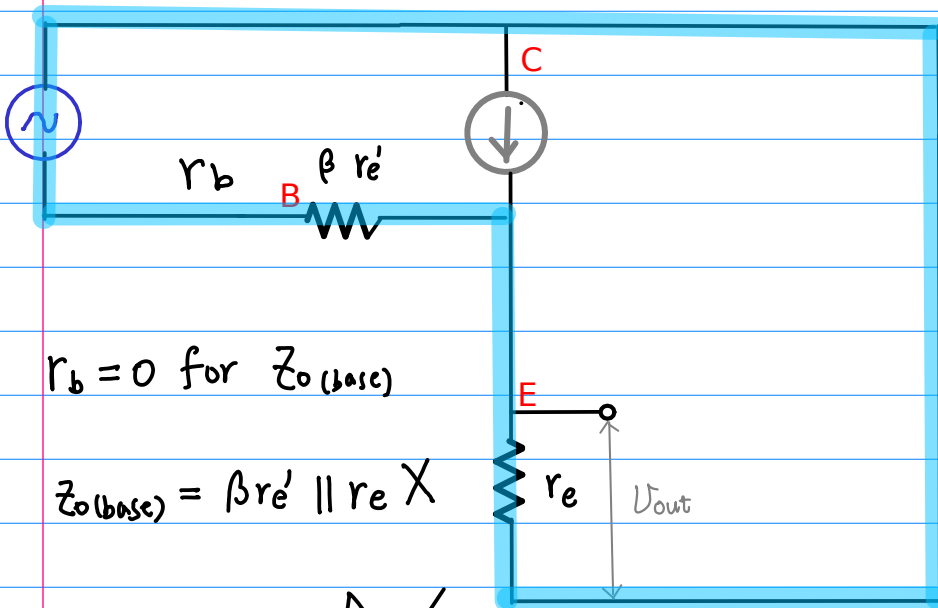
⊙ Z_o with respect to I_e
⇒ move r_e & r_e' to emitter

III
CC

Z_0

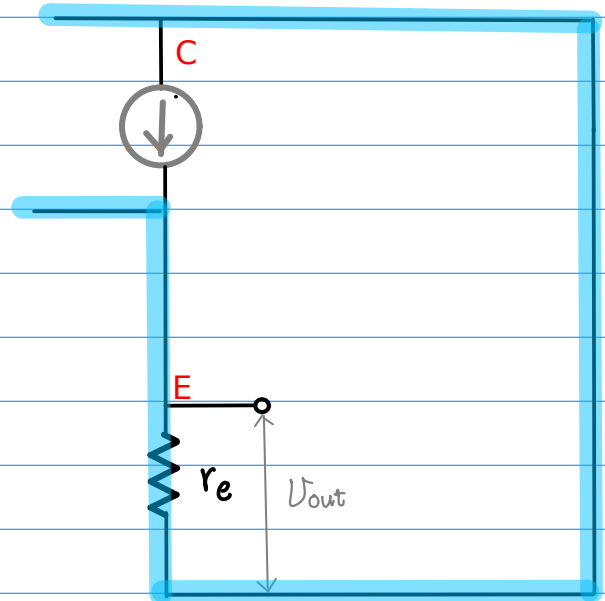
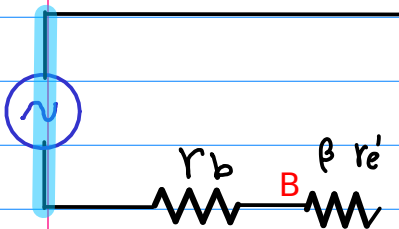
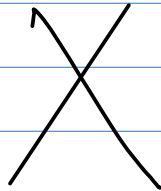


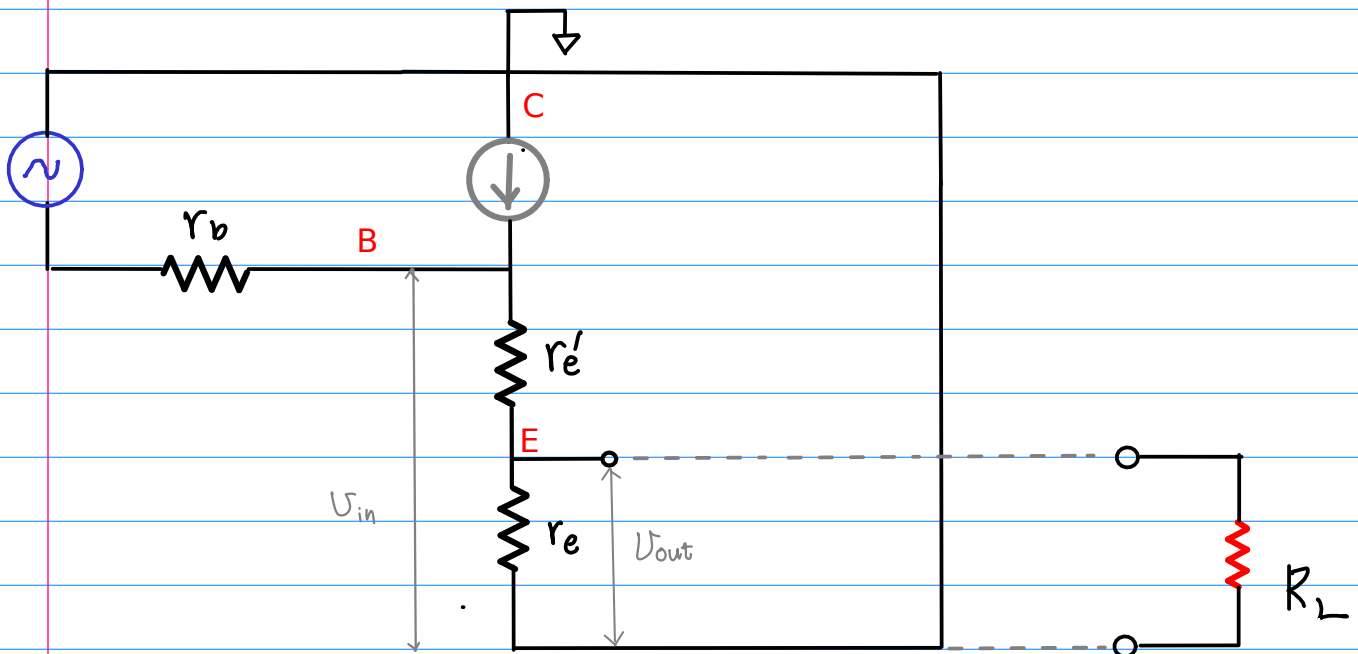
$$Z_{0(\text{base})} = \beta(r_e' + r_e) \parallel 0$$
$$\approx 0$$



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

$$Z_{o(\text{base})} = \beta r_e' \parallel r_e \quad \times$$





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

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

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

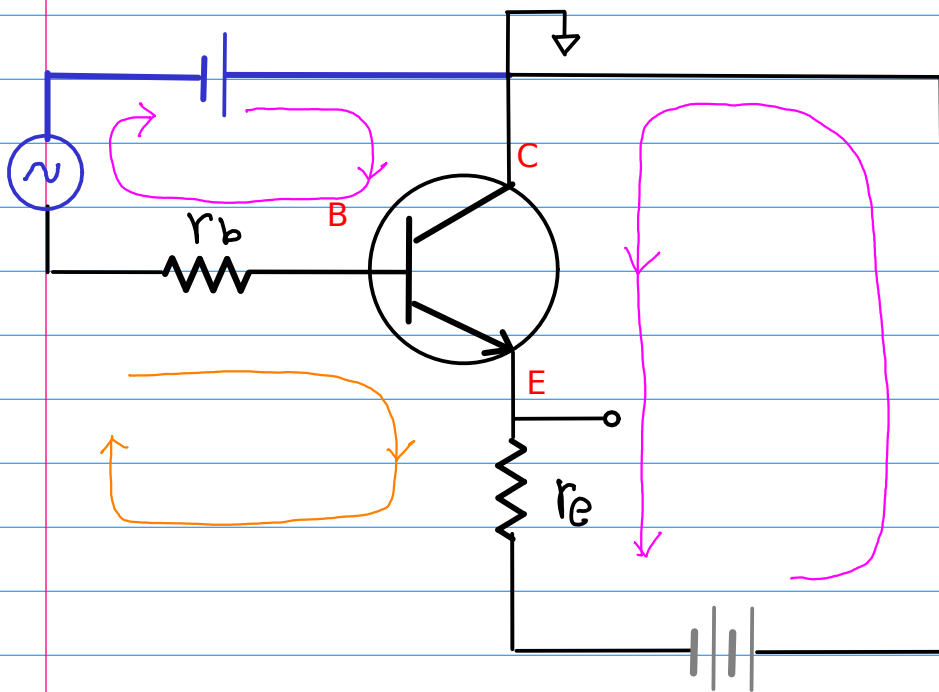
$$A_i = \frac{I_{out}}{I_{in}} = \frac{I_e}{I_b} = \beta + 1 \approx \beta$$





CC

CC



CC

