

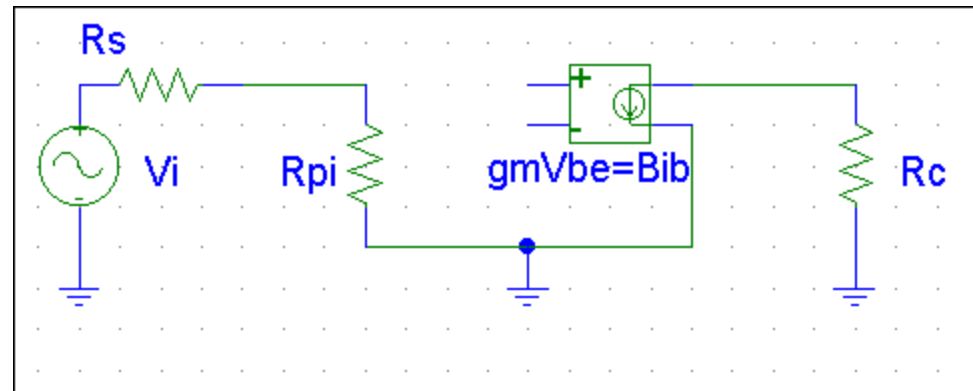
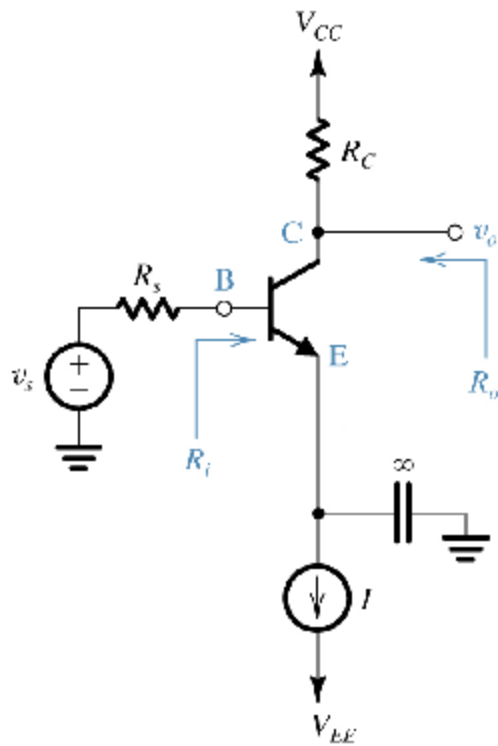
Basic single-stage BJT amplifier configurations

We will study 3 types of BJT amplifiers

- **CE - common emitter**, used for A_v , A_i , and general purpose
- **CE with R_E - common emitter with R_E** ,
same as CE but more stable
- **CC common collector**, used for A_i , low output resistance,
used as an output stage

CB common base (not covered)

Common emitter amplifier



ac equivalent circuit

Common emitter amplifier

R_{in}
(Does not include source)

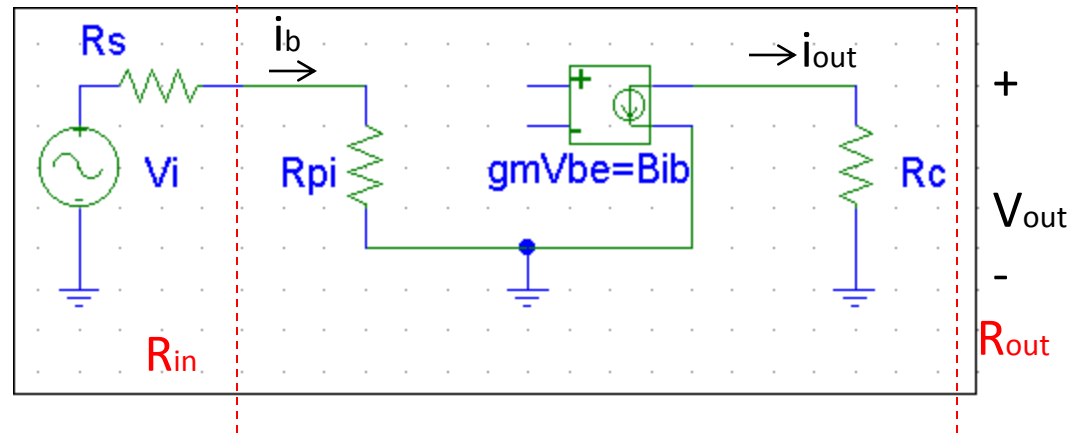
$$R_{in} = R_{pi}$$

R_{out}
(Does not include load)

$$R_{out} = R_C$$

A_v
 $= V_{out}/V_{in}$
 $V_{out} = -\beta i_b R_C$
 $V_{in} = i_b (R_s + R_{pi})$

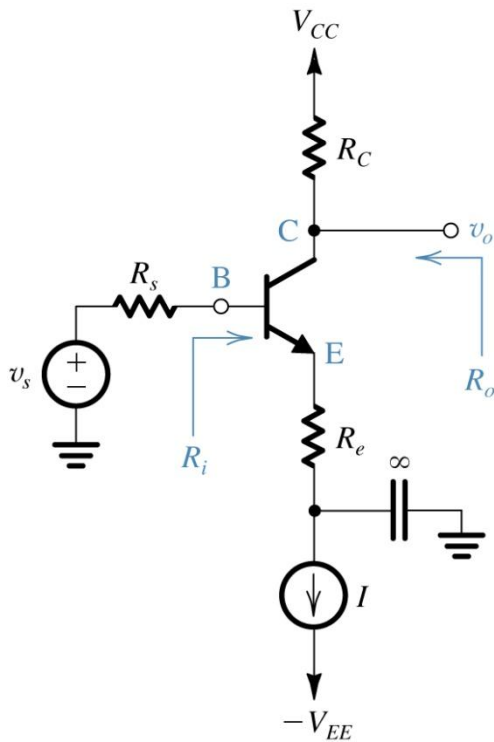
$$A_v = -\beta R_C / (R_s + R_{pi})$$



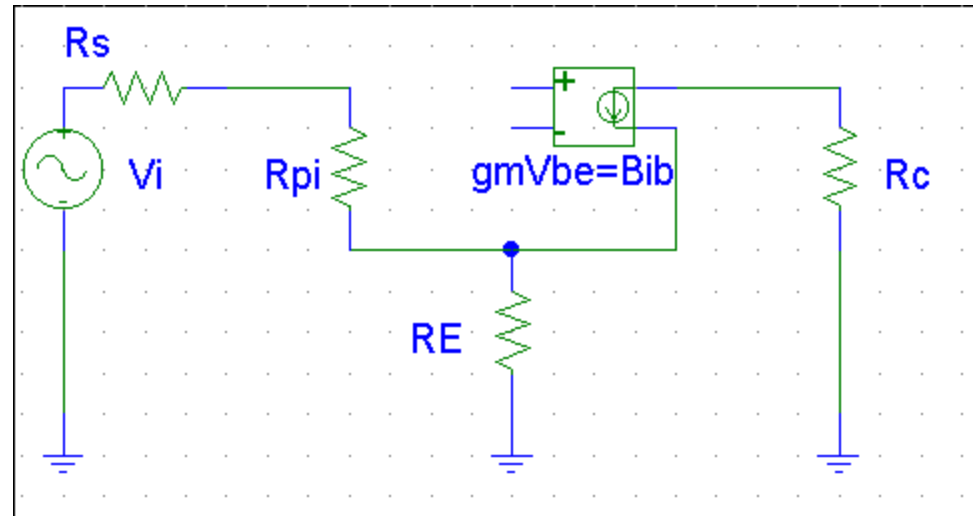
A_i
 $= i_{out}/i_{in}$
 $i_{out} = -\beta i_b$
 $i_{in} = i_b$

$$A_i = -\beta$$

Common emitter with R_E amplifier



(a)



ac equivalent circuit

Common emitter with R_E amplifier

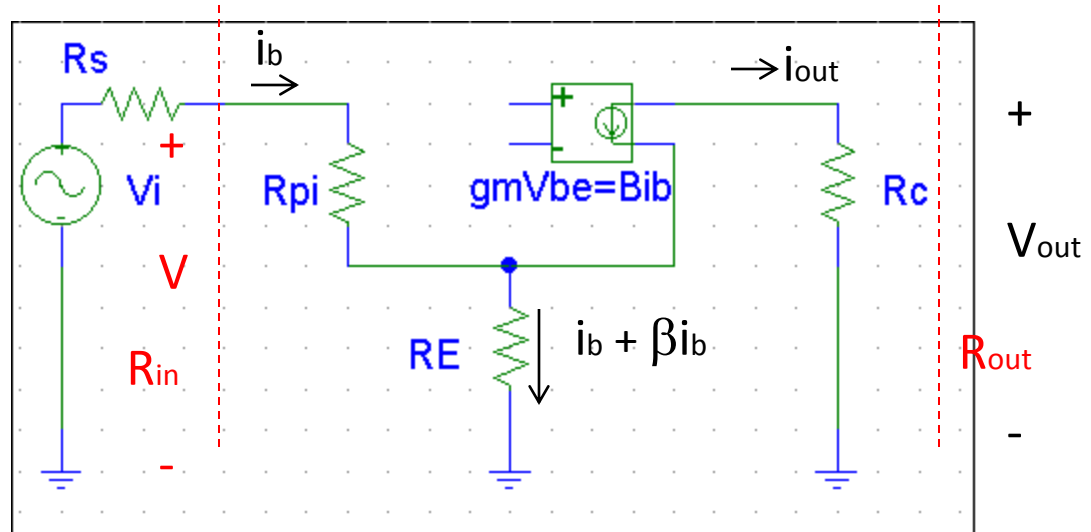
R_{in}

$$R_{in} = V/i_b$$

$$V = i_b R_{pi} + (i_b + \beta i_b) R_E$$

$$R_{in} = R_{pi} + (1 + \beta) R_E$$

(usually large)



R_{out}

$$R_{out} = R_C$$

A_v

$$= V_{out}/V_{in}$$

$$V_{out} = -\beta i_b R_C$$

$$V_{in} = i_b R_s + i_b R_{pi} + (i_b + \beta i_b) R_E$$

$$A_v = -\beta R_C / (R_s + R_{pi} + (1 + \beta) R_E)$$

(less than CE, but less sensitive to β variations)

A_i

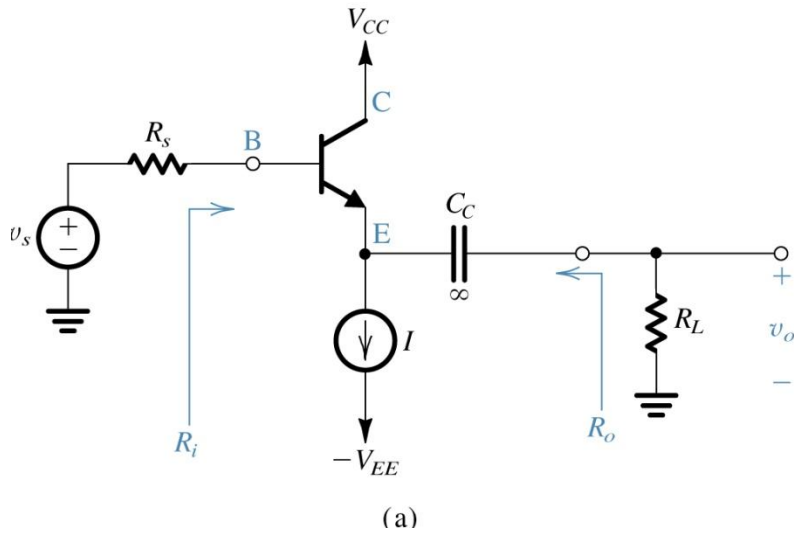
$$= i_{out}/i_{in}$$

$$i_{out} = -\beta i_b$$

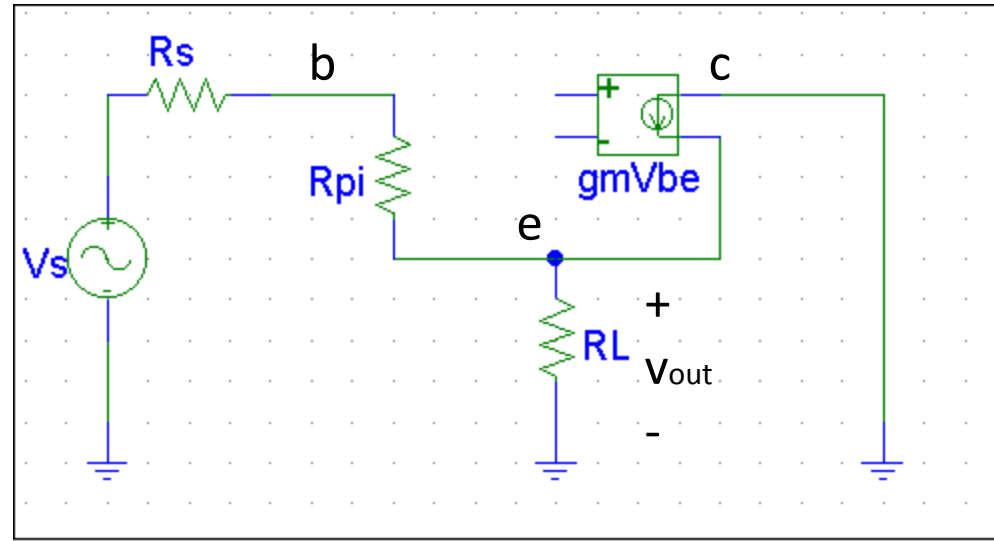
$$i_{in} = i_b$$

$$A_i = -\beta$$

Common collector (emitter follower) amplifier



(v_{out} at emitter)



ac equivalent circuit

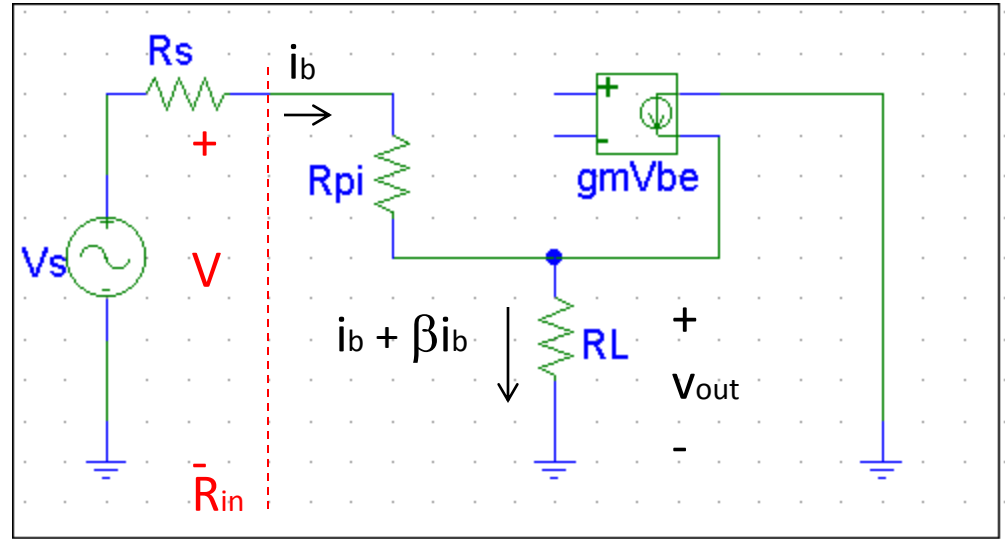
Common collector amplifier

R_{in}

$$R_{in} = V/i_b$$

$$V = i_b R_{pi} + (i_b + \beta i_b)R_L$$

$$R_{in} = R_{pi} + (1 + \beta)R_L$$



A_v

$$= v_{out}/v_s$$

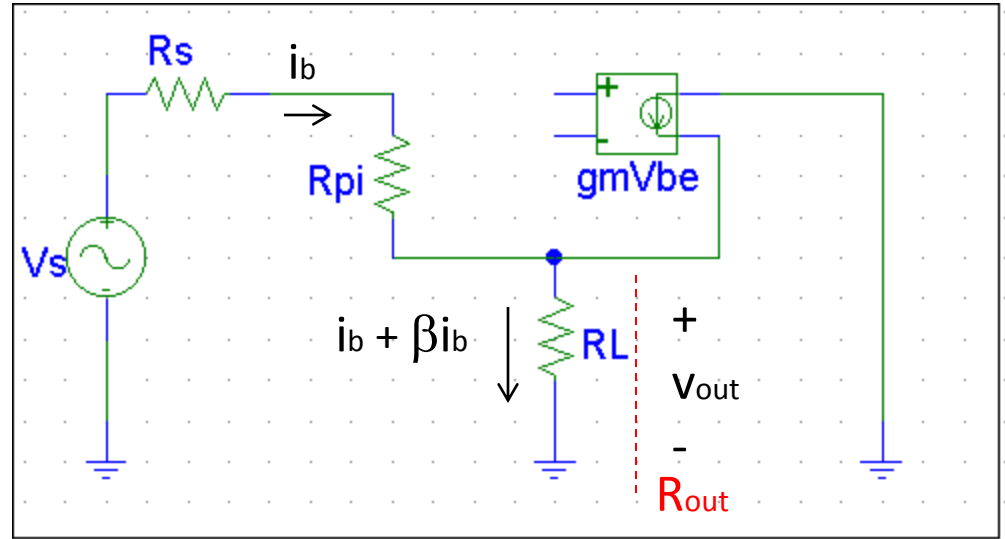
$$v_{out} = (i_b + \beta i_b)R_L$$

$$v_s = i_b R_s + i_b R_{pi} + (i_b + \beta i_b)R_L$$

$$A_v = (1 + \beta)R_L / (R_s + R_{pi} + (1 + \beta)R_L)$$

(always ≤ 1)

Common collector amplifier



A_i

$$= i_{out}/i_{in}$$

$$i_{out} = i_b + \beta i_b$$

$$i_{in} = i_b$$

$$A_i = \beta + 1$$

R_{out}

(don't include R_L , set $V_s = 0$)

$$R_{out} = v_{out} / - (i_b + \beta i_b)$$

$$v_{out} = -i_b R_{pi} + -i_b R_s$$

$$R_{out} = (R_{pi} + R_s) / (1 + \beta)$$

(usually low)