BJT transistors

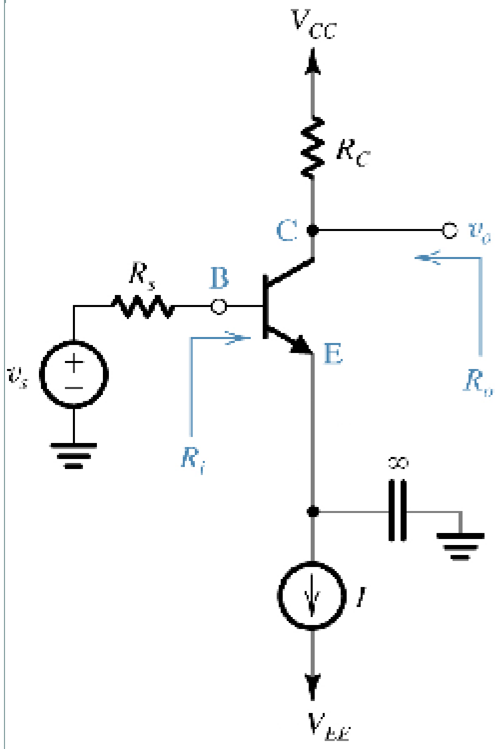
Basic single-stage BJT amplifier configurations

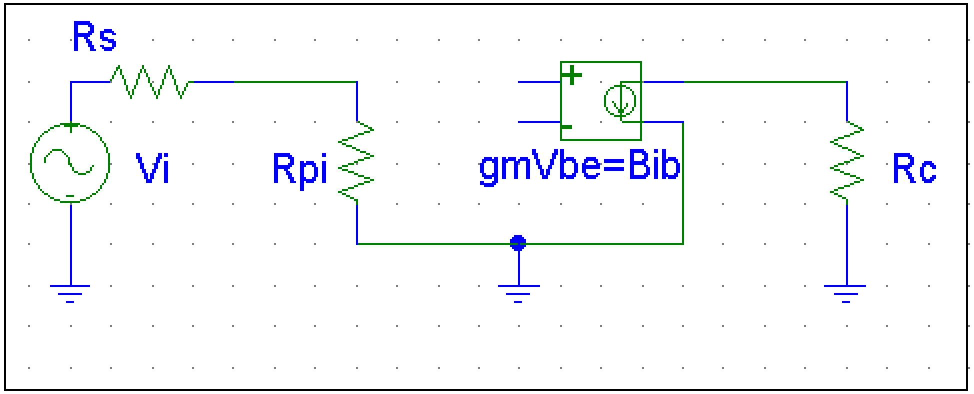
We will study 3 types of BJT amplifiers

- **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)

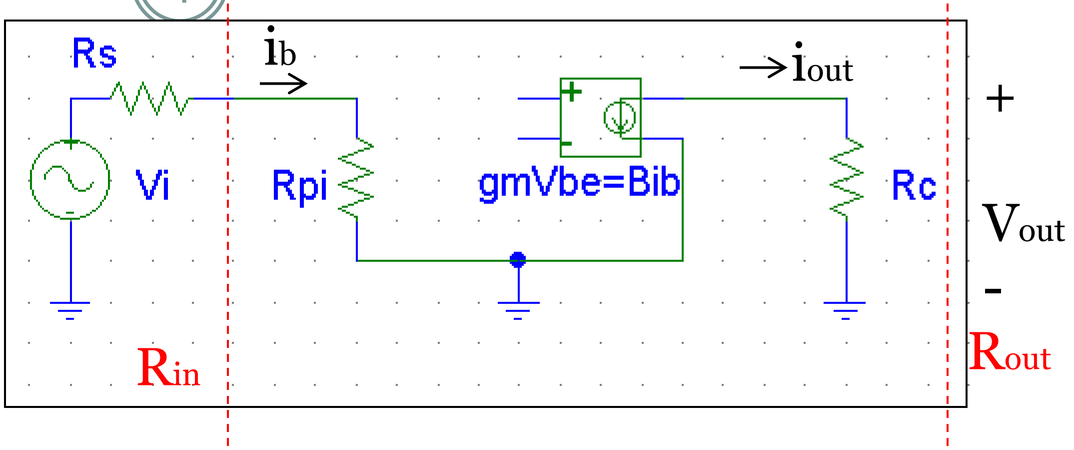
Common emitter amplifier





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

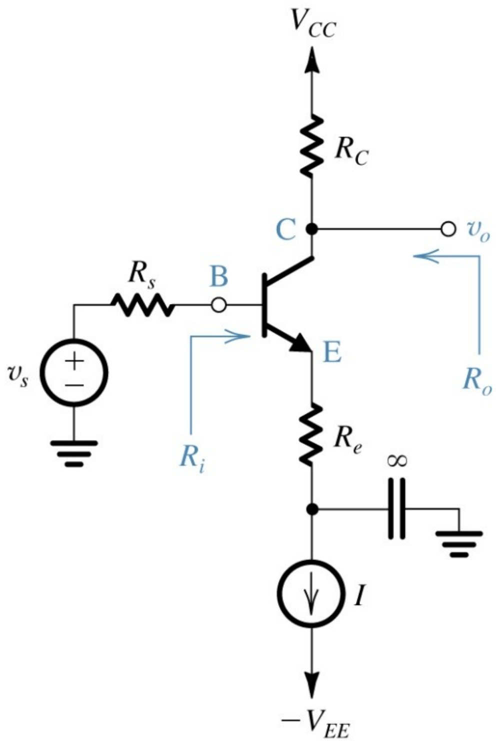
$= i_{out}/i_{in}$

$i_{out} = -\beta i_b$

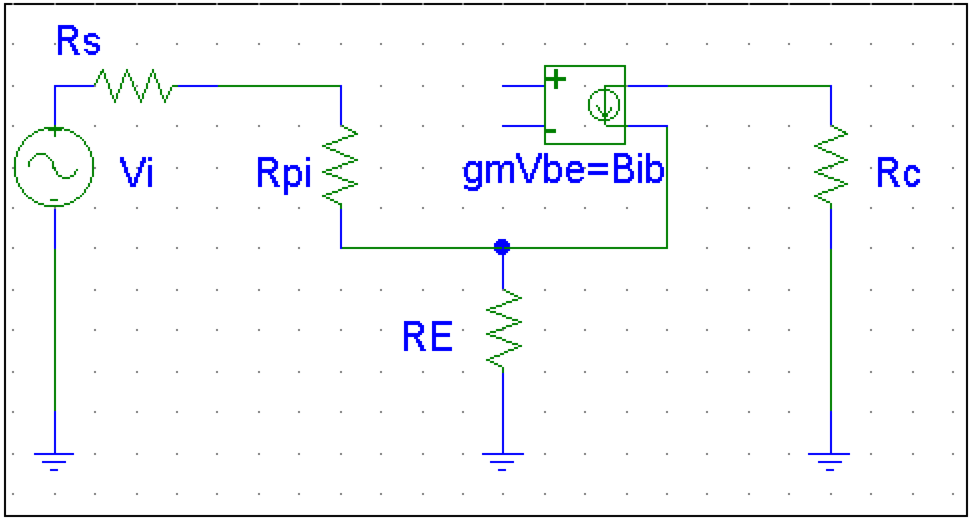
$i_{in} = i_b$

$A_i = -\beta$

Common emitter with R_E amplifier



(a)



ac equivalent circuit

Common emitter with R_E amplifier

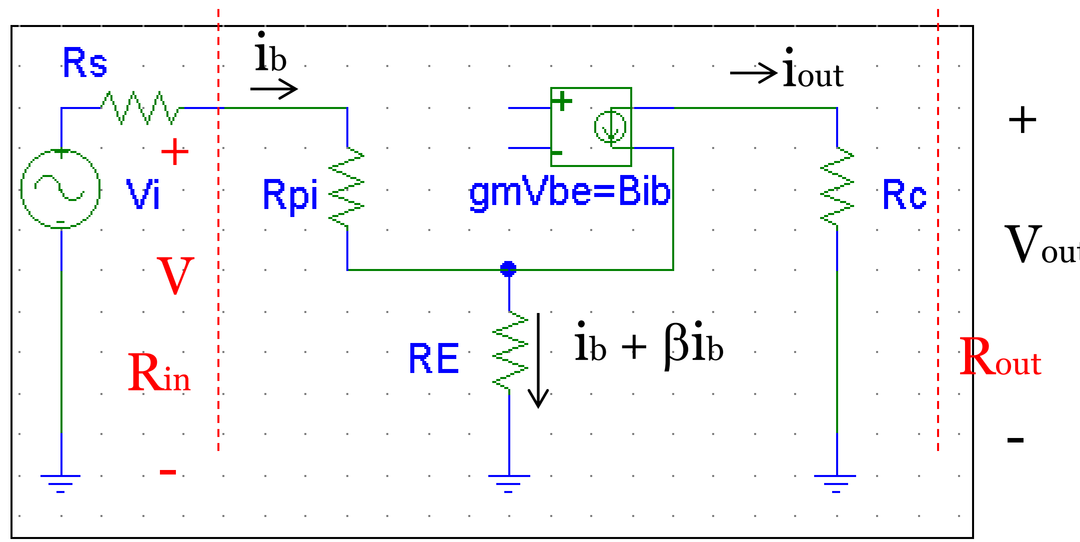
R_{in}

$R_{in} = V/i_b$

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

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

(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

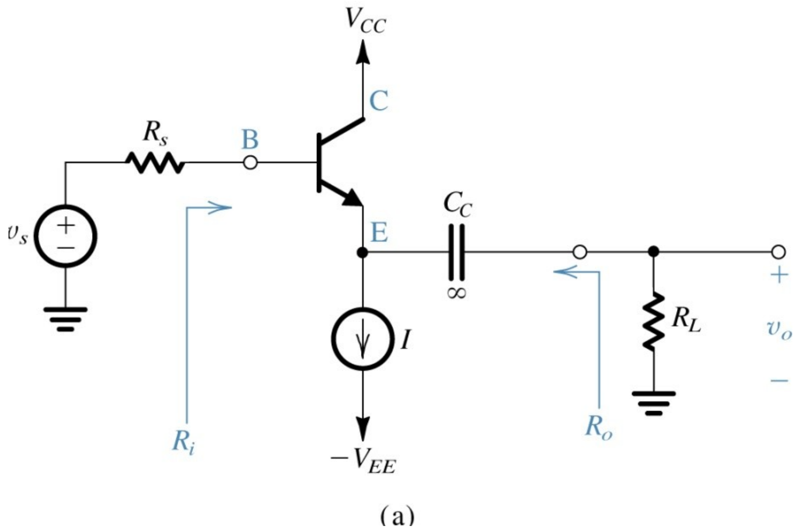
$= i_{out}/i_{in}$

$i_{out} = -\beta i_b$

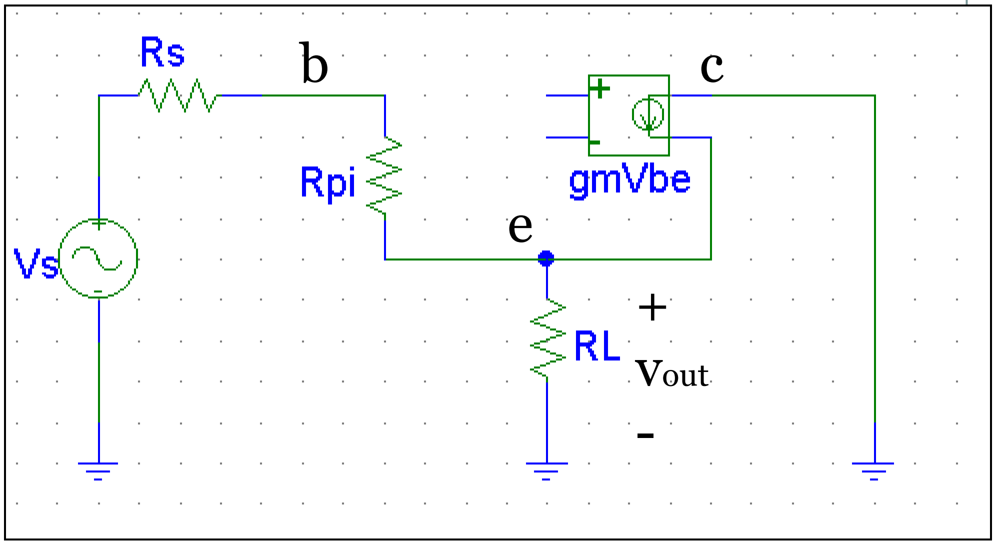
$i_{in} = i_b$

$A_i = -\beta$

Common collector (emitter follower) amplifier

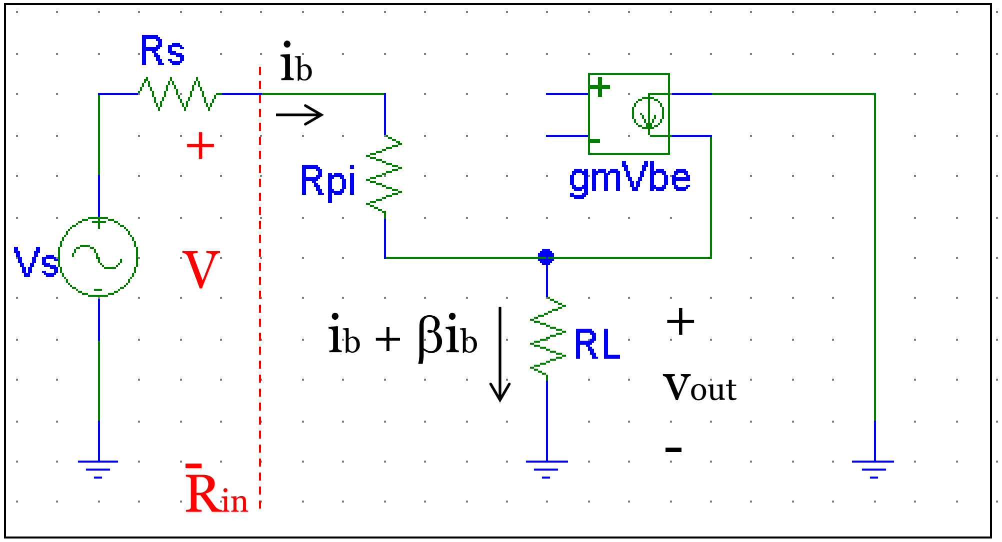


(Vout at emitter)



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

$= v_{out}/v_s$

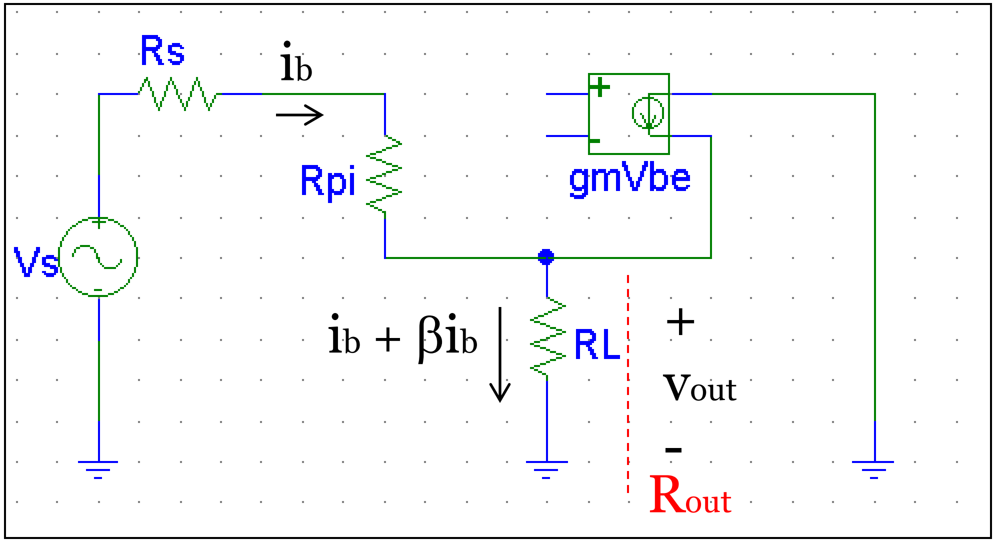
$v_{out} = (i_b + \beta i_b) R_L$

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

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

(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 RL, set Vs = 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)

Thank You