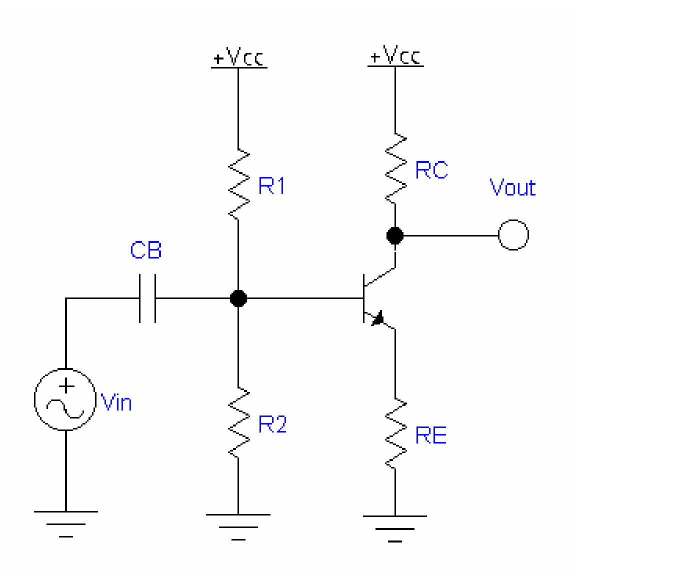
Transistor Amplifiers

Small Signal Modeling Examples

2. Common Emitter Amplifier (Voltage Divider Bias w/ R_E)



DC Bias

$V_B \approx V_{CC} [R_2 / (R_1+R_2)]$

if $(\beta+1)R_E >> R_1 \parallel R_2$

$V_E = V_B - 0.7$

$I_E = V_E / R_E$

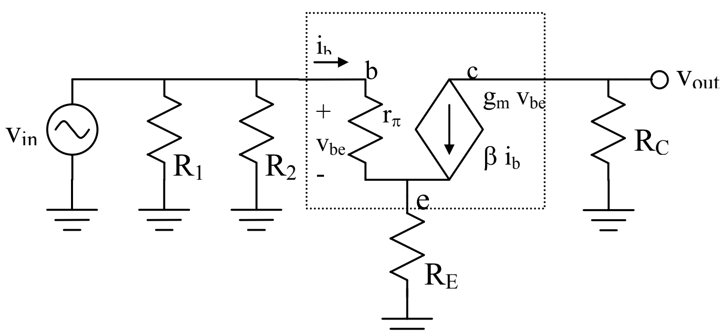
$I_C \approx I_E$

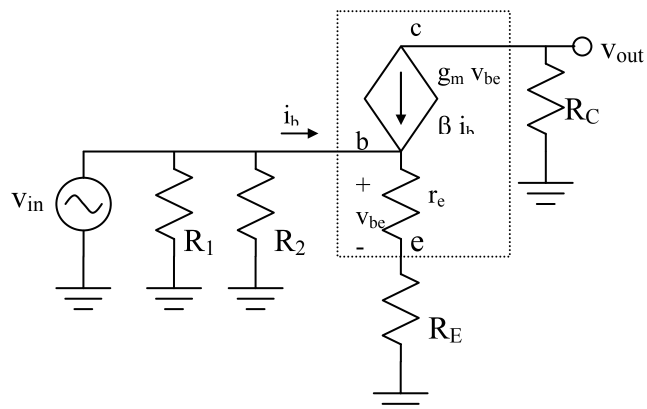
$V_{RC} = I_C (R_C)$

Check for saturation, ($V_{RC} > V_{CC}$)

$V_{OUT\,(BIAS)} = V_{CC} - V_{RC}$

Small Signal Models





Small Signal (ac) Parameters

$g_m = I_{C\,(BIAS)} / V_T$

$r_\pi = \beta / g_m$

$r_e = \beta /(\beta+1) (1/g_m) \approx 1/g_m$

Voltage Gain (Av)

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

$v_{in} = i_b r_\pi + (\beta+1)\ i_b R_E$

$= i_b (\beta+1) (R_E + r_e)$

$Av = v_{out} / v_{in} = - \beta R_C / [(\beta+1)(R_E + r_e)]$

$Av \approx - R_C / (R_E + r_e) \approx - R_C / R_E$, if $R_E >> r_e$

Input & Output Impedance (Rin, Rout)

$R_{in} = R_1 \parallel R_2 \parallel (r_\pi + (\beta+1) R_E)$

$= R_1 \parallel R_2 \parallel [(\beta+1) (R_E + r_e)]$

$R_{out} = R_C$

Notes:

(1) Voltage gain is controlled by R_C / R_E.

(2) R_{in} can be made quite large.