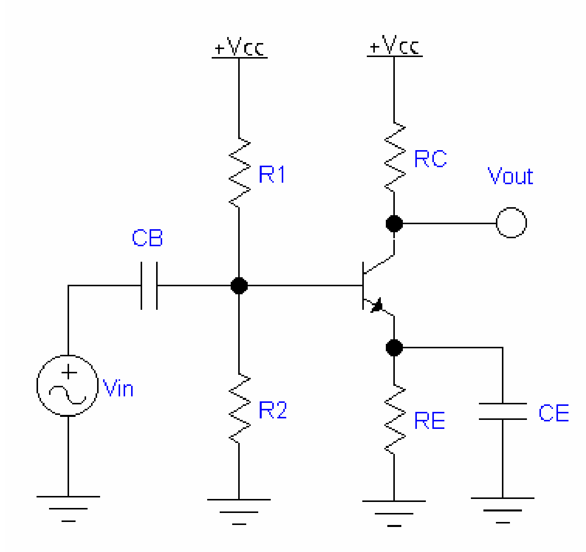
# Transistor Amplifiers

## Small Signal Modeling Examples

### 3. Common Emitter Amplifier w/ Voltage Divider Bias & Emitter Bypass Capacitor




**DC Bias**

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

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

$V_E = V_B - 0.7$

$I_E = V_E / R_E$

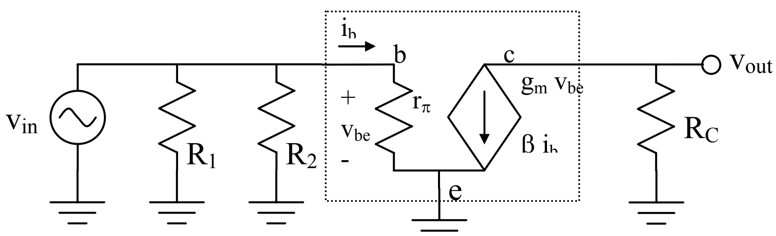
$I_C \approx I_E$

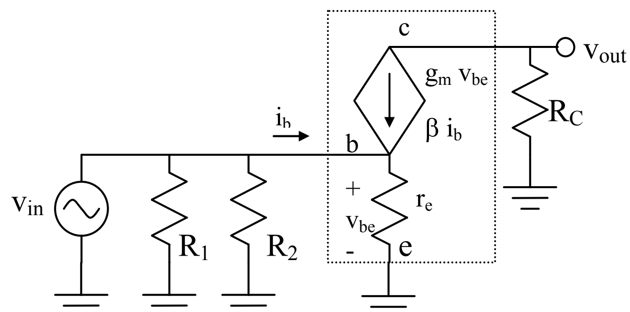
$V_{RC} = I_C ( R_C )$

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)**

$v_{out} = -g_m v_{be} R_C$

$v_{in} = v_{be}$

$Av = v_{out} / v_{in} = -g_m R_C$

$\approx - R_C / r_e$

**Input & Output Impedance (Rin, Rout)**

$R_{in} = R_1 \| R_2 \| r_\pi$

$= R_1 \| R_2 \| (\beta+1) r_e$

$R_{out} = R_C$

Notes: (1) $I_{C\,(BIAS)}$, $g_m$ and Av are fairly $\beta$ independent.

(2) Relatively high gains are achievable.