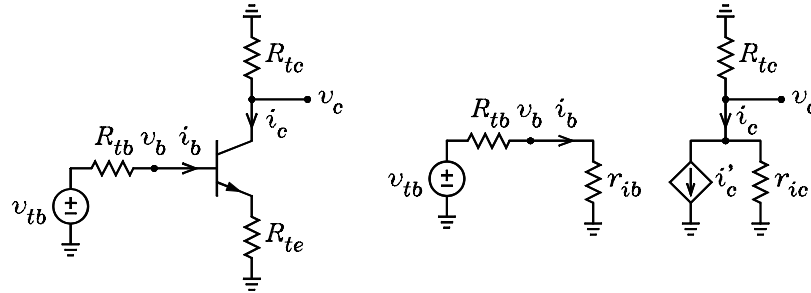


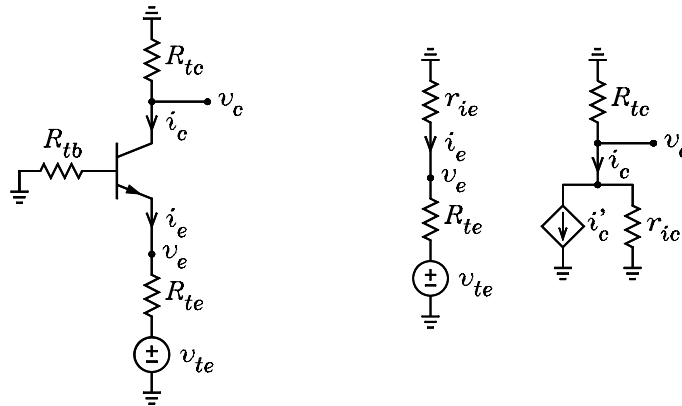
BJT Amplifier Small-Signal Equivalent Circuits ECE 3050 – Analog Electronics

The BJT Common-Emitter Amplifier



$$\begin{aligned}
 r_e &= \frac{V_T}{I_E} & r'_e &= \frac{R_{tb} + r_x}{1 + \beta} + r_e & r_0 &= \frac{V_A + V_{CE}}{I_C} \\
 r_{ib} &= r_x + (1 + \beta) r_e + R_{te} \frac{(1 + \beta) r_0 + R_{tc}}{r_0 + R_{te} + R_{tc}} & r_{ic} &= \frac{r_0 + r'_e \parallel R_{te}}{1 - \frac{\alpha R_{te}}{r'_e + R_{te}}} \\
 i_b &= \frac{v_{tb}}{R_{tb} + r_{ib}} & v_b &= \frac{r_{ib}}{R_{tb} + r_{ib}} v_{tb} \\
 i'_c &= \frac{\alpha}{r'_e + R_{te} \parallel r_0} \frac{r_0 - R_{te} / \beta}{r_0 + R_{te}} v_{tb} & i_c &= \frac{r_{ic}}{r_{ic} + R_{tc}} i'_c & v_c &= -i'_c (r_{ic} \parallel R_{tc})
 \end{aligned}$$

The BJT Common-Base Amplifier

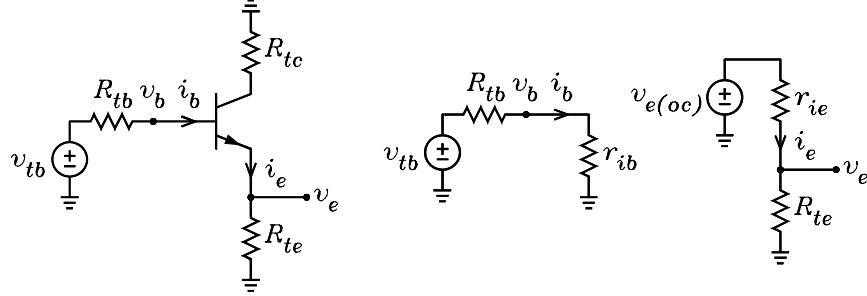


$$\begin{aligned}
 r_e &= \frac{V_T}{I_E} & r'_e &= \frac{R_{tb} + r_x}{1 + \beta} + r_e & r_0 &= \frac{V_A + V_{CE}}{I_C} \\
 r_{ie} &= \frac{r'_e \parallel (r_0 + R_{tc})}{1 - \frac{\alpha R_{tc}}{r'_e + r_0 + R_{tc}}} & r_{ic} &= \frac{r_0 + r'_e \parallel R_{te}}{1 - \frac{\alpha R_{te}}{r'_e + R_{te}}}
 \end{aligned}$$

$$i_e = -\frac{v_{te}}{R_{te} + r_{ie}} \quad v_e = \frac{r_{ie}}{R_{te} + r_{ie}} v_{te}$$

$$i'_c = -\frac{1}{R_{te} + r'_e \parallel r_0} \frac{\alpha r_0 + r'_e}{r_0 + r'_e} v_{te} \quad i_c = \frac{r_{ic}}{r_{ic} + R_{tc}} i'_c \quad v_c = -i'_c (r_{ic} \parallel R_{tc})$$

The BJT Common-Collector Amplifier



$$r_e = \frac{V_T}{I_E} \quad r'_e = \frac{R_{tb} + r_x}{1 + \beta} + r_e \quad r_0 = \frac{V_A + V_{CE}}{I_C}$$

$$r_{ib} = r_x + (1 + \beta) r_e + R_{te} \frac{(1 + \beta) r_0 + R_{tc}}{r_0 + R_{te} + R_{tc}} \quad r_{ie} = \frac{r'_e \parallel (r_0 + R_{tc})}{1 - \frac{\alpha R_{tc}}{r'_e + r_0 + R_{tc}}}$$

$$i_b = \frac{v_{tb}}{R_{tb} + r_{ib}} \quad v_b = \frac{r_{ib}}{R_{tb} + r_{ib}} v_{tb}$$

$$v_{e(oc)} = \frac{v_{tb}}{1 + \frac{r'_e}{r_0 + R_{tc} / (1 + \beta)}} \quad i_e = \frac{v_{e(oc)}}{r_{ie} + R_{te}} \quad v_e = \frac{R_{te}}{r_{ie} + R_{te}} v_{e(oc)}$$