# ECE 342
# Electronic Circuits

# Lecture 18
# Common Emitter – Part 2

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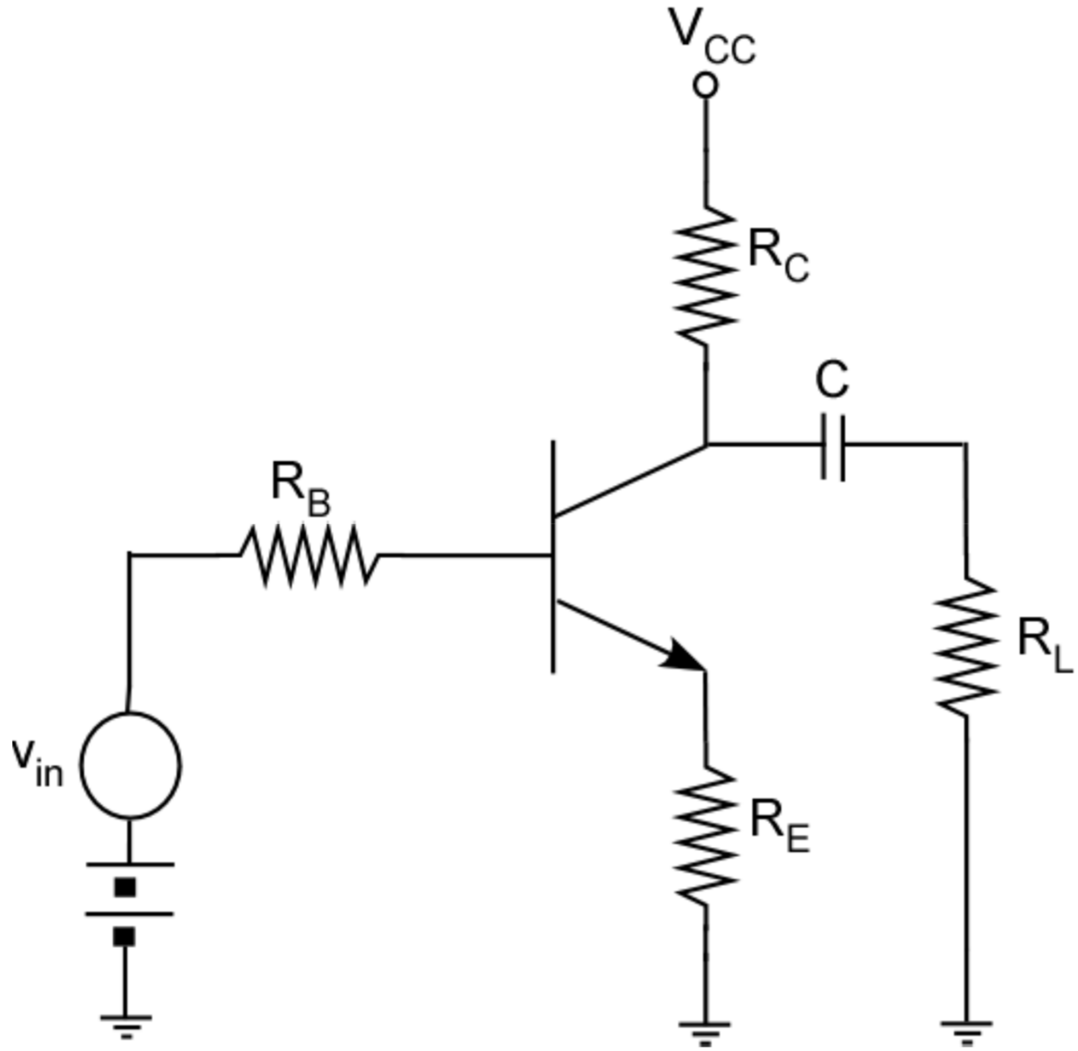
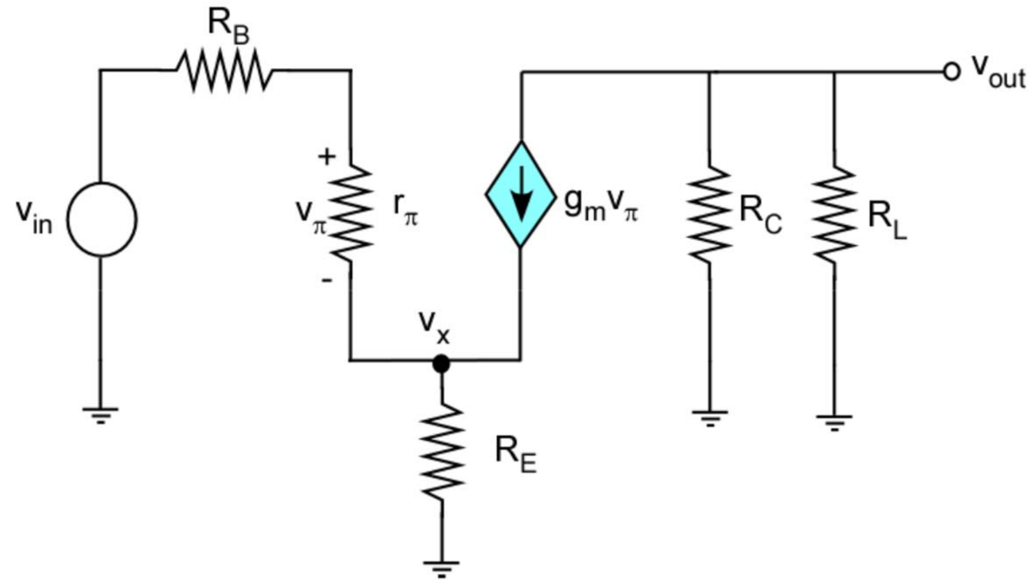
# CE with External Resistors



# CE with External Resistors

$$v_{out} = -g_m v_\pi \left(R_L \,||\, R_C\right)$$




$$\frac{v_x}{R_E} = g_m v_\pi + \frac{v_\pi}{r_\pi}$$

$$v_{in} = v_x + v_\pi + \frac{v_\pi}{r_\pi} R_B$$

$$v_{in} = \left( g_m R_E + \frac{R_E}{r_\pi} + 1 + \frac{R_B}{r_\pi} \right) v_\pi$$

$$v_{out} = -\frac{g_m \left(R_L \,||\, R_C\right) v_{in}}{g_m R_E + \frac{R_E}{r_\pi} + 1 + \frac{R_B}{r_\pi}}$$

# CE with External Resistors

$$\frac{v_{out}}{v_{in}} = -\frac{g_m r_\pi \left(R_L \,||\, R_C\right)}{g_m r_\pi R_E + R_E + r_\pi + R_B} = -\frac{g_m r_\pi \left(R_L \,||\, R_C\right)}{R_E\left(\beta+1\right) + r_\pi + R_B}$$

$$A_{MB} = -g_m\left(R_L \,||\, R_C\right)\frac{1}{\frac{R_E\left(\beta+1\right)}{r_\pi} + \frac{R_B}{r_\pi} + 1}$$

$$A_{MB} = -\frac{\beta\left(R_L \,||\, R_C\right)}{R_E\left(\beta+1\right) + r_\pi + R_B}$$

***$R_E$* and *$R_B$* degrade the gain**

# CE with External Resistors

The gain can be written as:

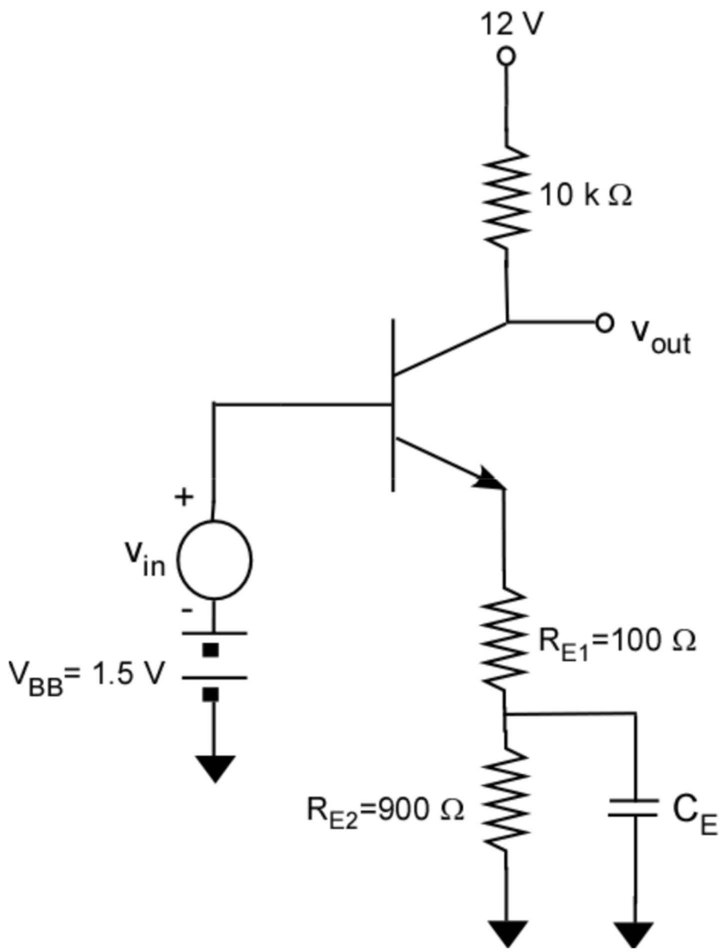
$$A_{MB} = -\frac{\beta\left(R_L \parallel R_C\right)}{R_E\left(\beta+1\right)+r_\pi + R_B} = -\frac{\left(\dfrac{\beta}{\beta+1}\right)\left(R_L \parallel R_C\right)}{R_E + \dfrac{r_\pi}{\left(\beta+1\right)} + \dfrac{R_B}{\left(\beta+1\right)}}$$

and since $\dfrac{\beta}{\left(\beta+1\right)} = \alpha$ neglecting $\dfrac{R_B}{\left(\beta+1\right)}$

$$A_{MB} = -\frac{\alpha\left(R_L \parallel R_C\right)}{R_E + r_e}$$

# Example

Given $V_{BEON}$=0.6V, find the gain for the circuit shown




$$V_{BQ} = 1.5\,V$$

$$V_{EQ} = 1.5\,V - 0.6\,V = 0.9\,V$$

$$I_E \simeq \frac{0.9}{R_{E1} + R_{E2}} = \frac{0.9}{1\,k\Omega} = 0.9\,mA$$

# Example (Cont')

$$I_C \simeq 0.9\, mA \Rightarrow V_{outQ} = 12\,V - 0.9 \times 10 = 3\,V$$

<u>AC analysis</u>: $R_{E2}$ is shorted and $R_E$=$R_{E1}$=100Ω. Since $\beta$ is not known, use:

$$A_{MB} = -\frac{\alpha R_C}{R_E + r_e} \quad with \quad \alpha \simeq 1$$

$$r_e = \frac{V_T}{I_E} = \frac{26}{0.9} = 28.8\,\Omega$$

$$A_{MB} = -\frac{10,000}{100 + 28.8} = -77.5$$

$$A_{MB} = -77.5$$