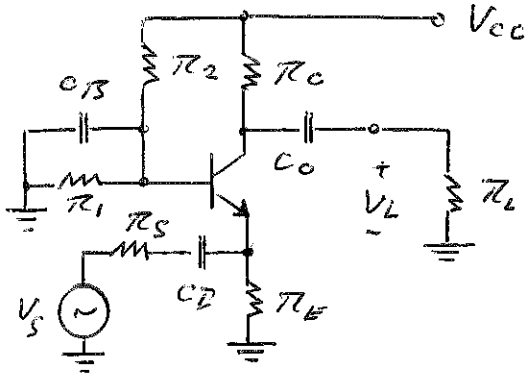
CE Amplifier Example



Transistor

$\beta = 100$

$V_A = 75V$

$V_{BEa} \cong 0.7V$

$nV_T \cong 30mV$

$V_{cc} = 10V$	$R_1 = 5.6k\Omega$	$C_2 = 27\mu F$	$f_L = 100Hz$
$R_c = R_L = 10k\Omega$	$R_2 = 27k\Omega$	$C_o = 2\mu F$	
$R_E = 2k\Omega$	$R_S = 40\Omega$	$C_B = 4.7\mu F$	

Find: • Q-point (I_{CQ}, V_{CEQ})

• $A_V = \frac{V_L}{V_s}$

Step 1: DC Analysis

$$I_{Ca} = \frac{V_{cc}\frac{R_1}{R_1+R_2} - V_{BEa}}{\frac{R_B}{\beta} + (1+\frac{1}{\beta})R_E}$$

$R_B = 4.6k\Omega$

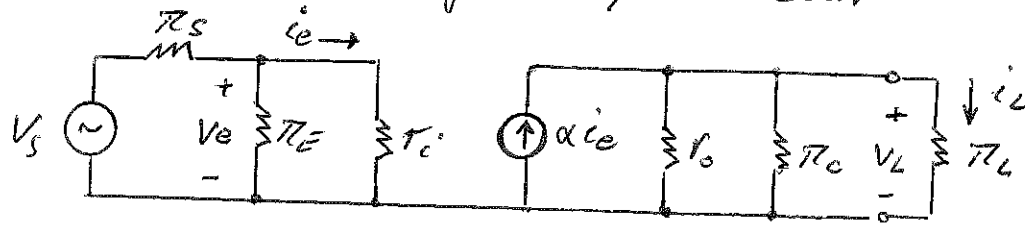
$$I_{Ca} \cong 0.49$$

$$V_{CEa} = V_{cc} - I_{Ca}(R_c + R_E[1+\tfrac{1}{\beta}])$$

$$V_{CEQ} \cong 4.1V$$

Step 2: AC Analysis (caps act as shorts)

Small signal eq. Circuit



$r_i = \frac{\alpha}{g_m} \cong \alpha \frac{nV_T}{I_{CQ}} \cong 60\,\Omega$ $\quad r_o = (1/s)\frac{V_A}{I_{CQ}} \cong 15\,M\Omega$

$\tilde{R}_L = r_o \| R_C \| R_L \cong 5\,k\Omega$ $\quad r_o$ is typically neglected

Equations

$$V_e = i_e r_i$$

$$V_L = \alpha i_e \tilde{R}_L$$

$$V_e = V_S \cdot \frac{r_{in}}{R_S + r_{in}} \quad \text{where } r_{in} = R_E \| r_i \cong 58\,\Omega$$

$$A_V = \frac{V_L}{V_S} = \frac{r_{in}}{R_S + r_{in}} \cdot \frac{\alpha \tilde{R}_L}{r_i} \cong 49$$

$$A_I = \frac{i_L}{i_e} \cong \alpha \frac{R_C}{R_C + R_L} \cong 0.50$$

$$r_{out} = R_C \| r_o \cong 10\,k\Omega$$

Note: Due to the low input resistance, the CB gain stage is frequently preceded by a CE or a CC gain stage