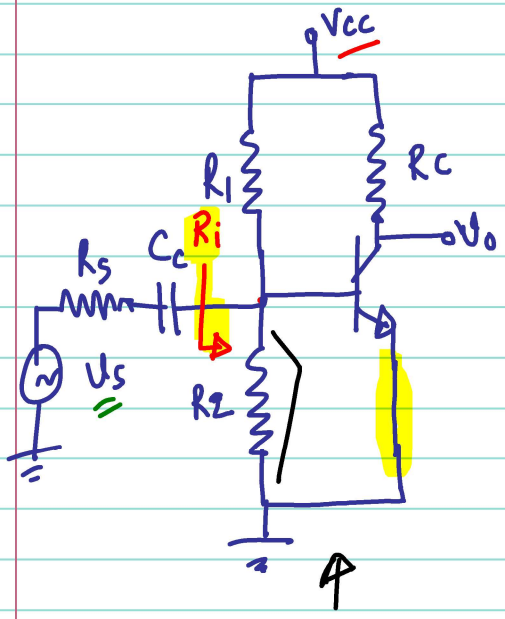
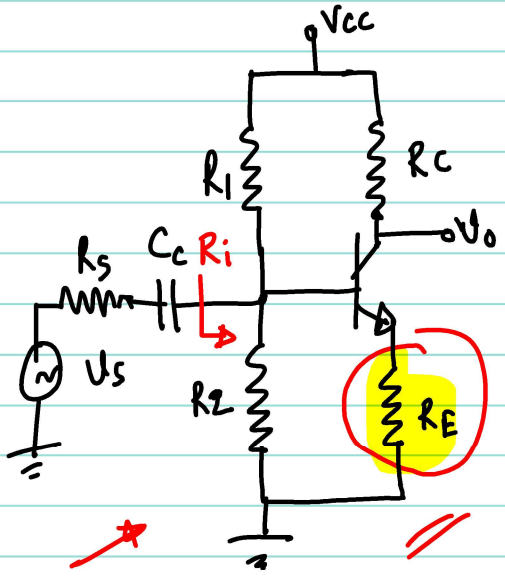
Lec-19

CE Amplifier with/without emitter resistor:





Input resistance R_i

R_i higher

$R_i = R_1 \| R_2 \| r_\pi$

$R_i = R_1 \| R_2 \| [r_\pi + (1+\beta) R_E]$

typical values, r_π = few kΩ

R_1 = tens of kΩ

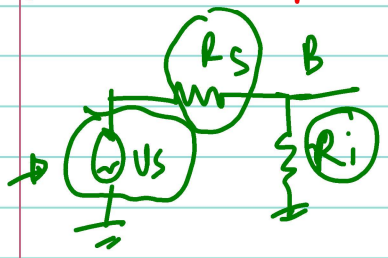
R_2 = " "

$R_i > R_2$

$\text{gain} = -g_m \cdot (R_C \| r_o) \dfrac{R_1 \| R_2 \| r_\pi}{R_1 \| R_2 \| r_\pi + R_s}$

$\text{gain} = -\dfrac{\beta R_C}{r_\pi + (1+\beta) R_E} \left(\dfrac{R_i}{R_i + R_s}\right)$

$\approx -\dfrac{R_C}{R_E}$



$R_E \uparrow$, gain $\downarrow$

$R_E \downarrow$, gain $\uparrow$.

β, gain $= -\dfrac{\beta R_C}{r_\pi + (1+\beta) R_f} \times \dfrac{R_i}{R_i + R_s}$

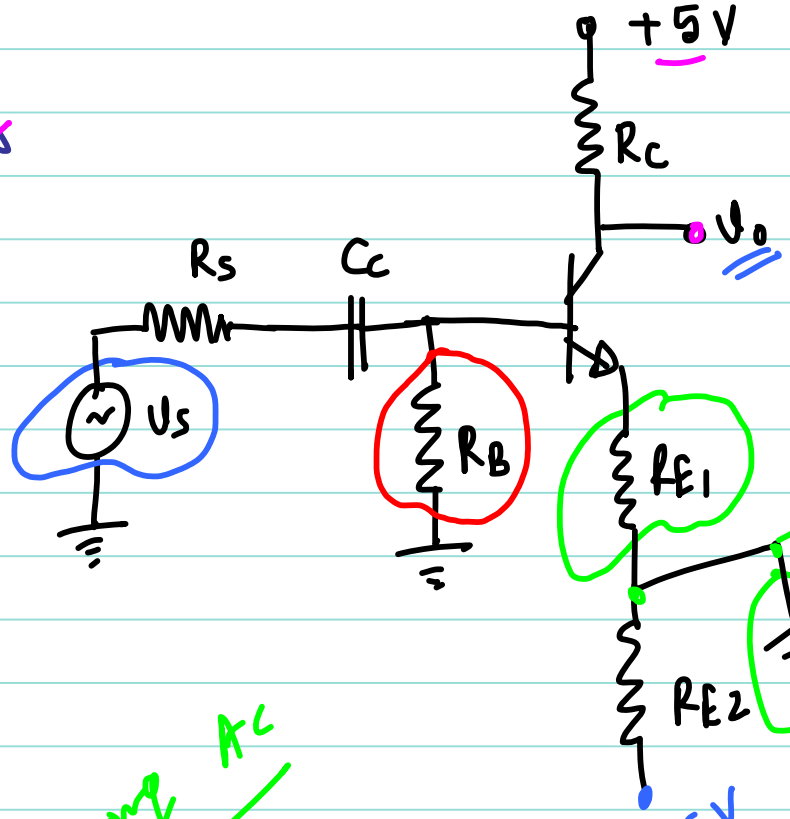
$r_\pi \ll (1+\beta) R_f$

$\text{gain} = -\dfrac{R_C}{R_f}$

$r_\pi \uparrow$ $I_C \downarrow$

CE Amplifier with emitter bipass capacitor.

Notice Dual Supply (+)(-)V



gain = $\frac{-R_C}{R_E}$

gain = $\frac{-R_C}{R_{E1}}$

$R_{E1} < R_{E2}$

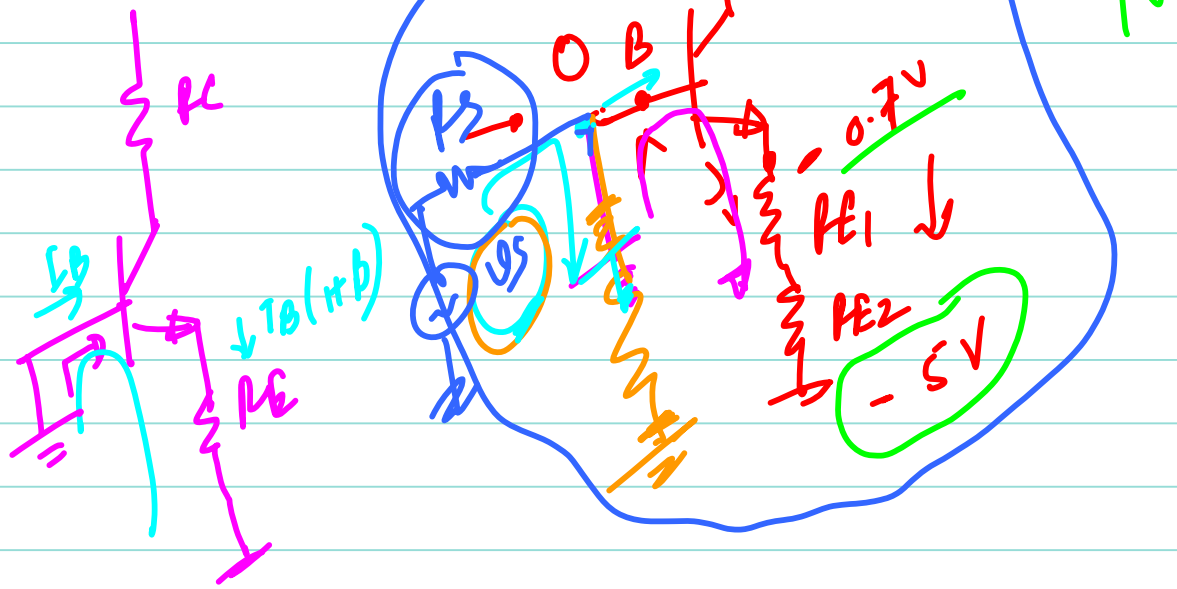
AC

DC

Dump AC

R_{E1}, R_{E2}

R_{E1}

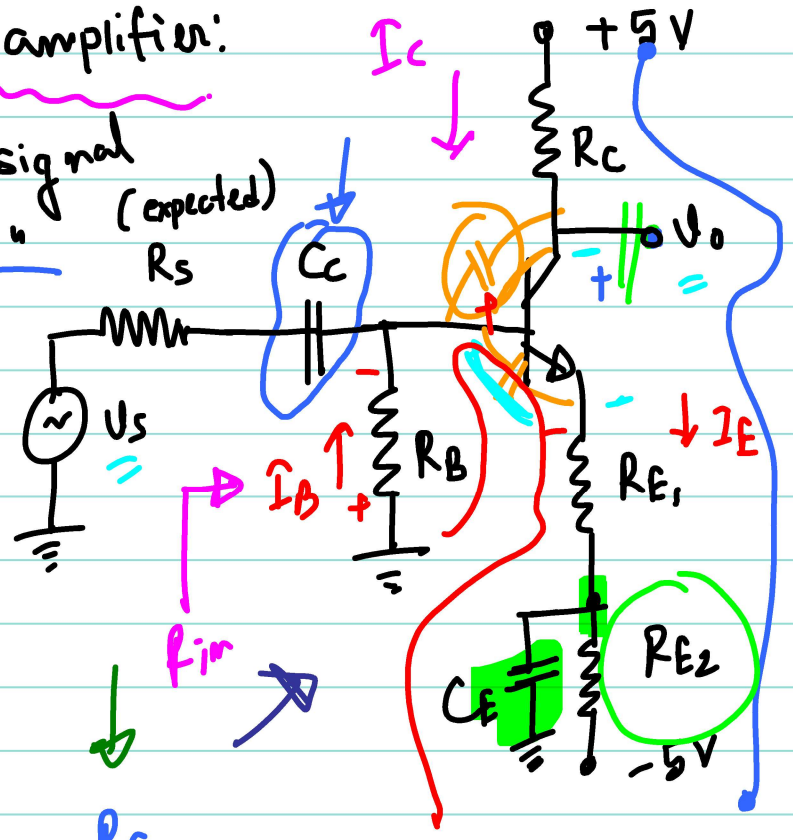


Example Design the BJT based amplifier:

- $V_s \rightarrow 12$ mV Sinusoidal signal
- $V_o \rightarrow 0.4$V " " "
- $I_E \approx 0.2\,mA \approx I_C$ (expected)
- $V_{CEQ} \approx 4$V

Given, $\beta = 100$ (Range 75-125)

$V_{BE-ON} = 0.7$V



$R_B = 100\,k\Omega$

$$|Gain| = \frac{0.4\,V}{0.012\,V} = 33.3 \approx + \frac{R_C}{R_{E1}} \rightarrow 150\,\Omega$$

$$\frac{R_C}{R_{E1}} > 33.3 \;;\; \frac{R_C}{R_{E1}} = 40, \quad R_C = 40\,R_{E1}$$

$$-I_B R_B - V_{BE-ON} - I_E (R_{E1} + R_{E2}) = -5\,V \;;\; I_E = (1+\beta) I_B$$

$$(1+\beta) I_B$$

$$R_{E1} + R_{E2} = 20.5\,k\Omega$$

$$5 - I_C R_C - V_{CE} - I_E (R_{E1} + R_{E2}) = -5 \;;\; R_C = 9.5\,k\Omega$$

$$\frac{R_C}{R_{E1}} = 40, \quad R_C = 9.5\,k\Omega, \quad R_{E1} = 0.238\,k\Omega \;\; 238\,\Omega$$

$$R_{E2} = 20.3\,k\Omega \;\; 20.3\,k\Omega$$

→ $R_{E1} = 240\,\Omega$, $R_{E2} = 20\,k\Omega$, $R_C = 10\,k\Omega$

DC analysis → I_{CQ} → DC

AC Analysis → r_π, g_m → gain →

$r_\pi \,||\, (1+\beta) R_E$

Expected

$|A_V| = 33.3$

$V_o = 0.40\,V$

$R_E = R_{E1} = 240\,\Omega$

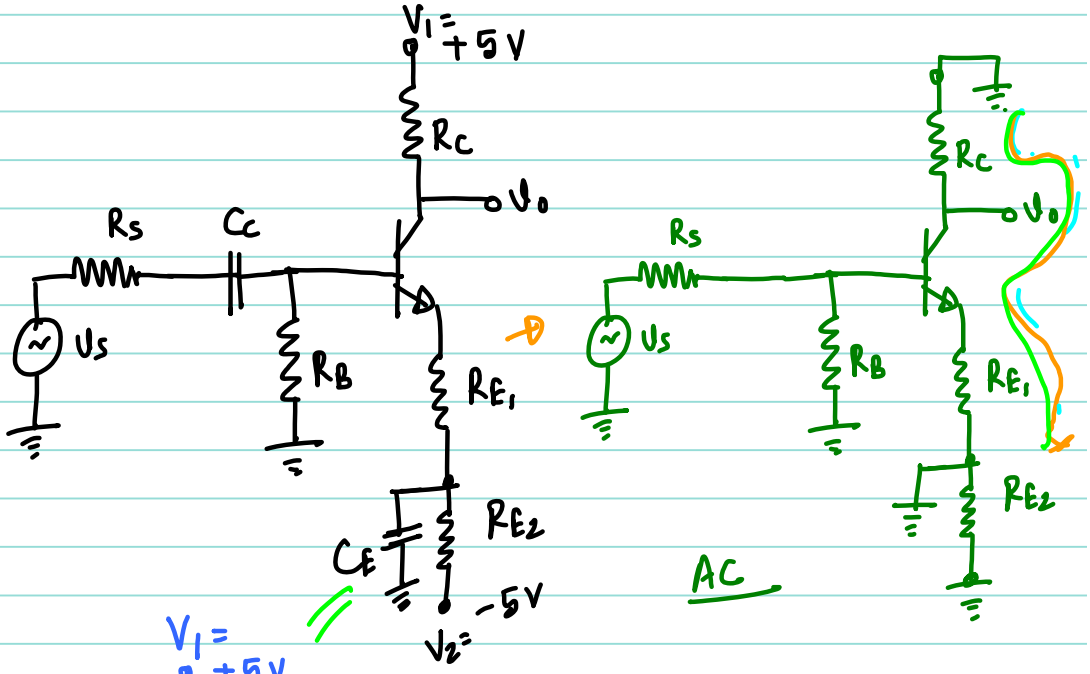
$(1+\beta) 240\,\Omega = 24.24\,k\Omega$

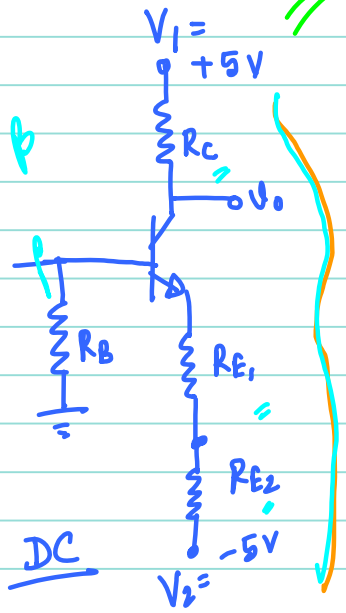
$r_\pi = \frac{I_E}{\beta V_T} = \frac{0.2\,mA}{40 \times 0.025} \approx 131\,\Omega$

$r_\pi \cong 1.3\,k\Omega$

β	I_{CQ} (mA)	$\lvert A_V \rvert$	V_o (V)
→ 100	0.201	26.4 →	0.317 → 33.3

AC load line and its use:





Notice that: AC and DC ckts are different