25.02.2022

Emitter-Biased Amplifier Circuit

Recap: Small-signal amplifier utilizing base-bias circuit.

- We follow 10% rule

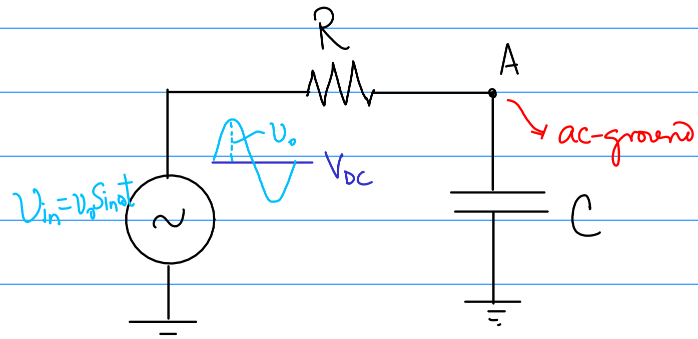
$\Rightarrow$ the amplitude of ac signal (current/voltage) $\leq$ 10% of the dc bias current/voltage

Last class: Base-bias amplifier ckt.

- Here the BJT is base-biased
- In base-biasing, Q-point is "Unstable" (it depends on β_{DC})

Emitter-Bias Amplifier Ckt:

- Stable Q-point (independent of β_{DC})
- Voltage-Divider Bias (VDB) Circuit / TSEB
- We are going to use additional Capacitor connected in parallel to the emitter resistor (R_E). This capacitor is termed as 'By-pass Capacitor'.



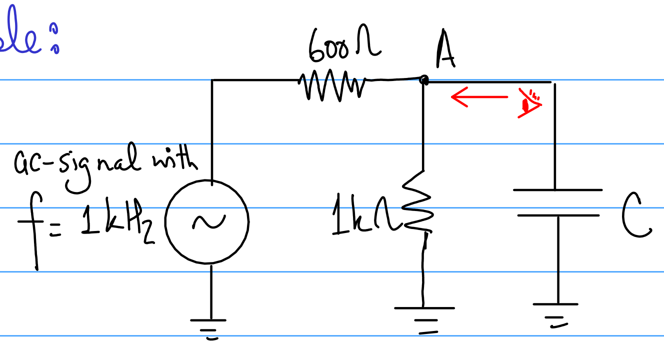
$$X_C = \frac{1}{\omega C}$$

Suppose, $R \geq 10 X_C$

$\Rightarrow$ All ac voltage drops across the resistor R.

$\Rightarrow$ The point 'A' is an ac ground.

Example:



For what value of the capacitor 'C', the point 'A' appears to be the ac-ground.

Equivalent resistance as seen by the capacitor at point 'A'.

$$R_{eq,A} = R_{Th} = 600\,\Omega \,||\, 1\,k\Omega = \frac{600 \times 1000}{600 + 1000} = 375\,\Omega$$

For the capacitor to work as by-pass capacitor,

$$X_c \leq \frac{R_{eq}}{10}$$

$$X_c \leq 37.5\,\Omega$$

$$\frac{1}{2\pi f C} \leq 37.5\,\Omega$$

$$\Rightarrow \quad C \geq \frac{1}{(2\pi f)(37.5)}$$

$$\Rightarrow \quad C \geq \frac{1}{2 \times 3.14 \times 1000 \times 37.5}$$

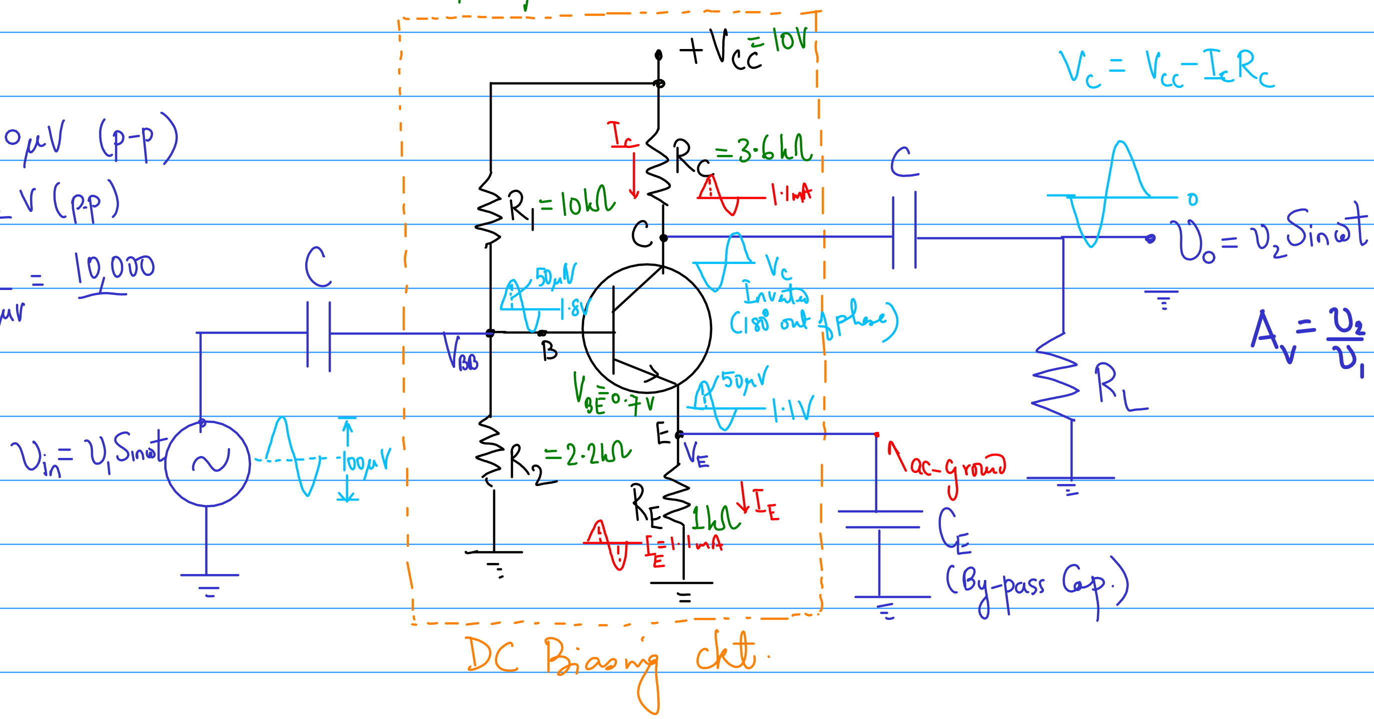
$$\Rightarrow \quad \boxed{C \geq 4.2\,\mu F}$$

Emitter-Bias Amplifier :

$v_{in} = 100\mu V$ (p-p)

$v_o = 1V$ (p-p)

$$A_v = \frac{1V}{100\mu V} = \underline{10,000}$$



DC Analysis :

$$V_{BB} = \frac{R_2}{R_1 + R_2} \cdot V_{CC} = \left[\frac{2.2k\Omega}{10k\Omega + 2.2k\Omega}\right] \cdot 10V = 1.8V$$

$$V_E = V_{BB} - V_{BE} = 1.8V - 0.7V = 1.1V$$

$$I_E = \frac{V_E}{R_E} = \frac{1.1V}{1k\Omega} = 1.1mA$$

$$I_C \approx I_E = 1.1mA$$

$$V_C = V_{CC} - I_C R_C = 10V - (1.1mA)(3.6k\Omega)$$

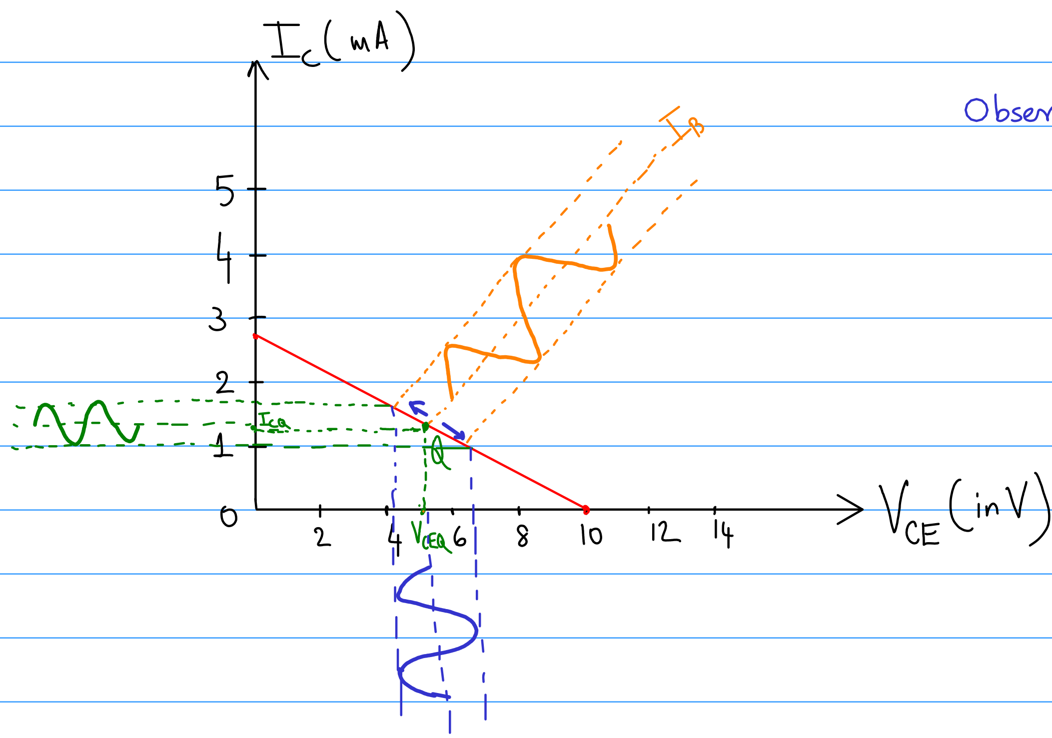
$$V_C = 10V - 3.96V = 6.04V$$

$$V_{CE} = V_C - V_E = 6.04V - 1.1V = 4.94V$$

Q-point : 4.94V ; 1.1 mA

$$I_{C,sat} = \frac{V_{CC}}{R_C} = \frac{10V}{3.6k\Omega} = 2.7 \text{ mA}$$

$$V_{CE,cut\text{-}off} = V_{CC} = 10V$$



Observation: Q-point lies nearly at the middle of the load-line