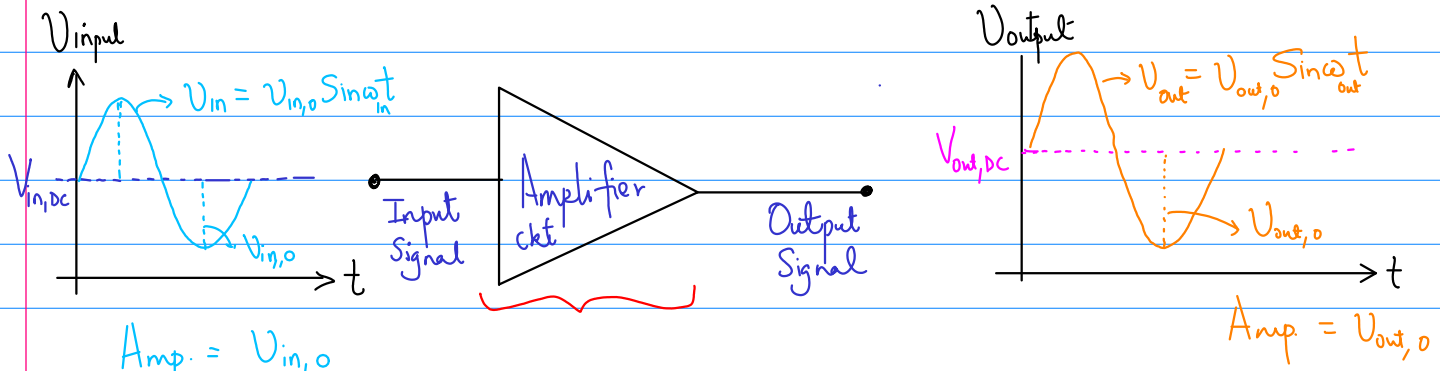
23.11.2023

BJT Amplifiers

(Small Signal Amplifiers) {10% Rule}

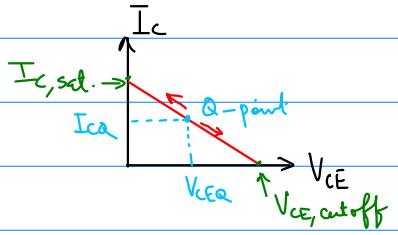
DC Biasing: It establishes stable dc operating point (Q-point)



Amp. = $v_{in,o}$

$v_{out,o} \gg v_{in,o}$ and $\omega_{in} = \omega_{out}$

$$\Rightarrow \quad \frac{v_{out,o}}{v_{in,o}} \gg 1$$



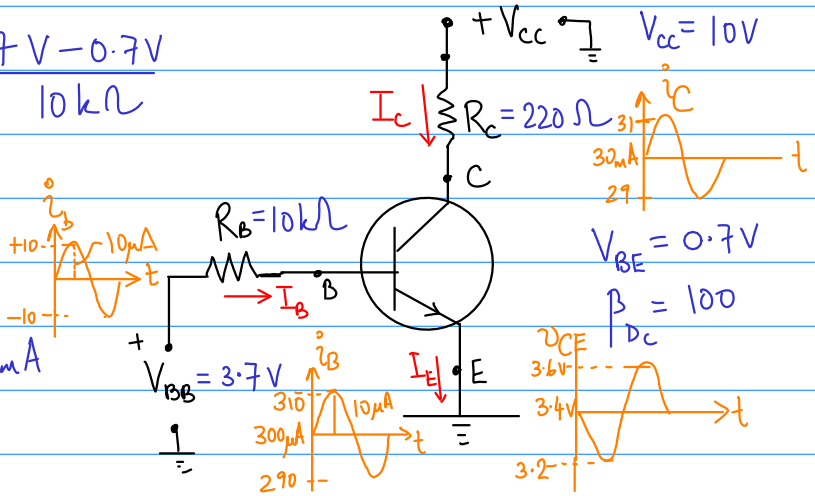
Small-Signal Amplifier: Variation about the 'Q-point' is relatively small.

Example: Lets look at a base-bias ckt. such that the Q-point lies nearly in middle of the load-line.

$$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{3.7\,V - 0.7\,V}{10\,k\Omega}$$

$$I_B = 0.3\,mA = 300\,\mu A$$

$$I_C = \beta_{DC} I_B = 100 \times 300\,\mu A = 30\,mA$$



$$V_C \downarrow = V_{CC} - I_C \uparrow R_C = 10V - (30mA)(220\Omega)$$

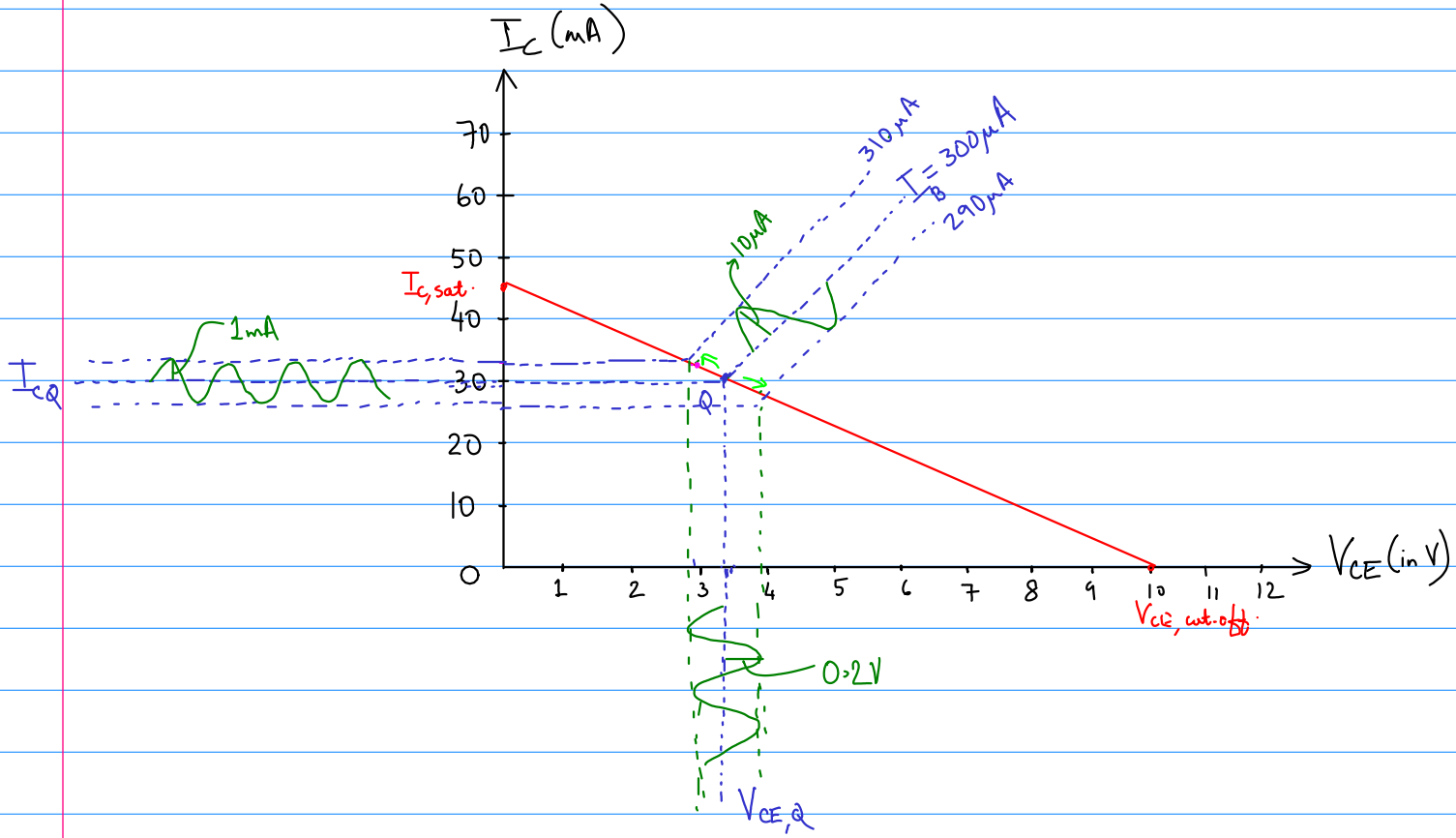
$$V_C = 3.4V$$

$$\Rightarrow \quad V_{CE} = V_C - V_E = 3.4V - 0V = 3.4V$$

Q-point : 3.4V ; 30mA

$$I_{C,sat.} = \frac{V_{CC}}{R_C} = \frac{10V}{220\Omega} = 45.5mA$$

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



Amplitude of the input base-current = 10μA

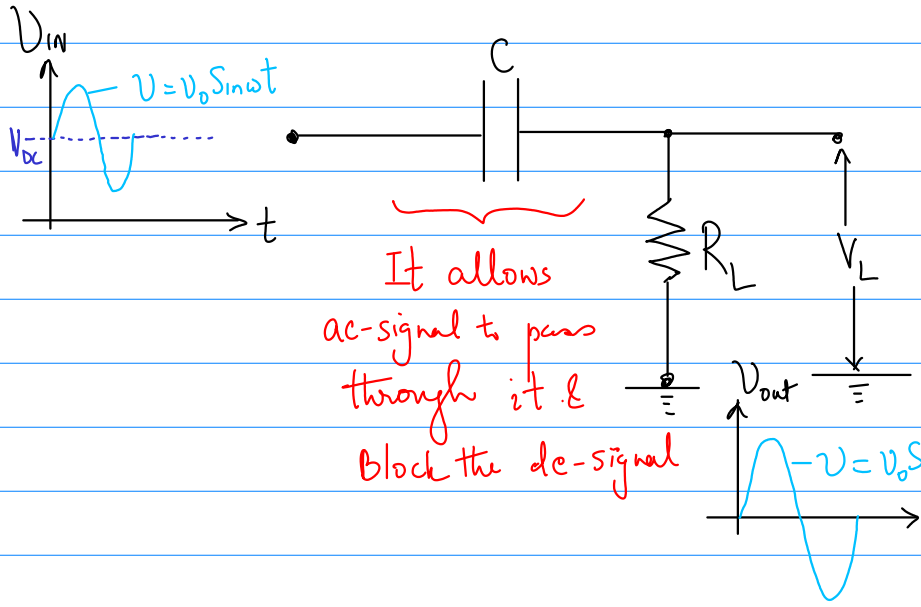
Amplitude of the output collector-current = 2mA

$$\frac{i_{CO}}{i_{BO}} = \frac{2mA}{10\mu A} = 200$$

$\Rightarrow$ Input signal is amplified by 200 times.

Ques: How do we couple / decouple ac-signal to the dc current/voltage level.

To perform this task, we make use of a capacitor called "COUPLING CAPACITOR".



It allows ac-signal to pass through it & block the dc-signal

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

Case(i) $\omega \to 0$; $X_C \to \infty$

$\Rightarrow$ when we have DC signal then the capacitor behaves as "OPEN".

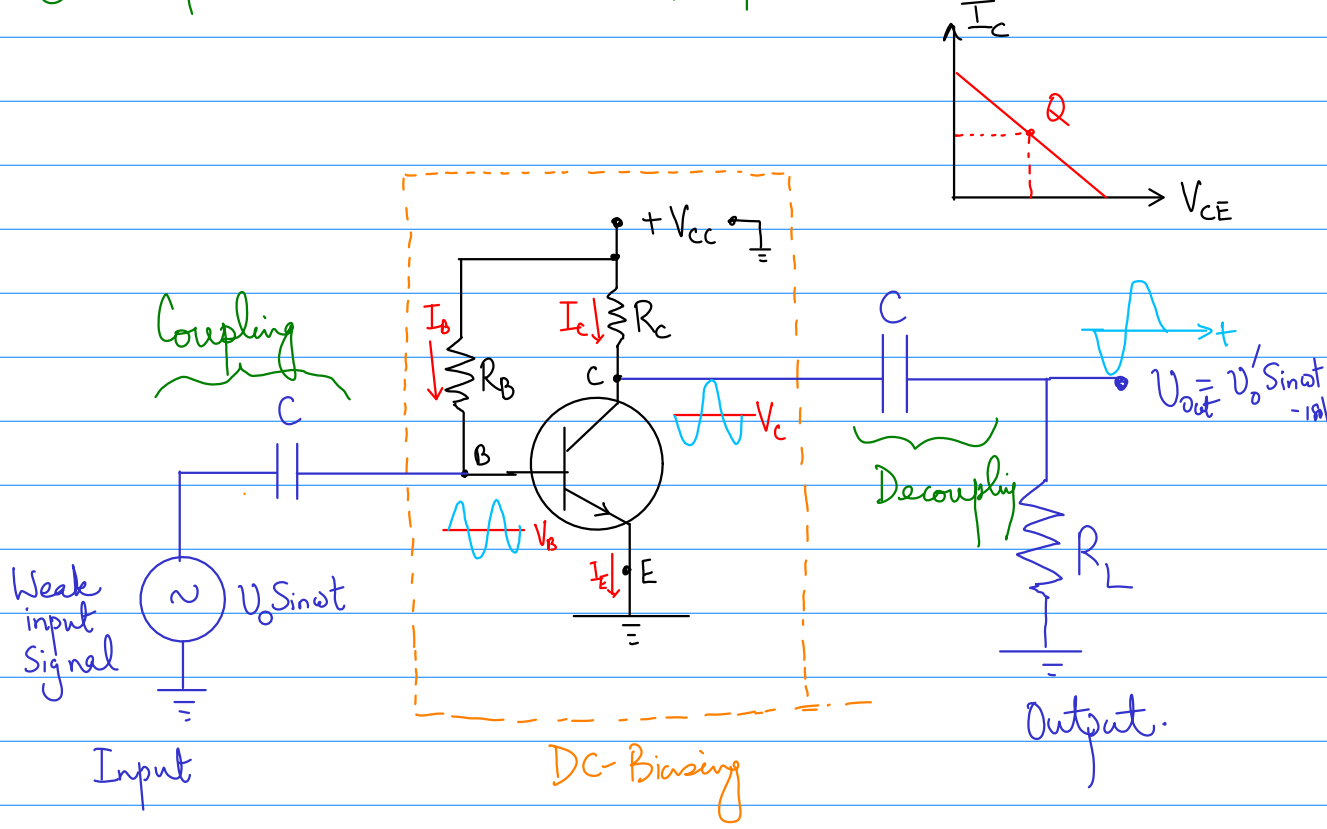
Case(ii) $\omega \to \infty$; $X_C \to 0$

$\Rightarrow$ when we have high freq. ac-signal then the capacitor is behaving as "SHORT".

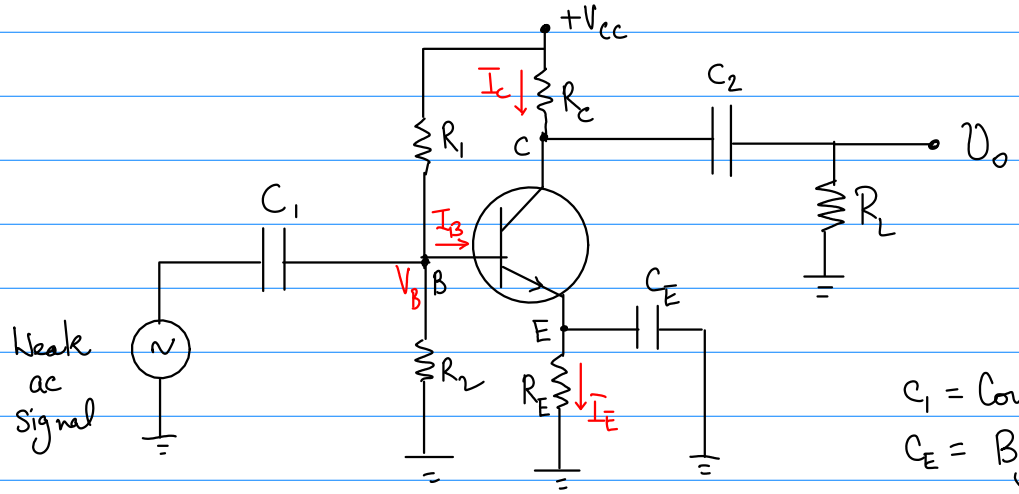
For firm coupling / decoupling.

$$\boxed{R_L \geq 10 X_C}$$

Design of a base-bias amplified ckt.



Common-Emitter Amplifier Circuit :



C_1 = Coupling Cap.
C_E = By-pass Cap.
C_2 = Decoupling Cap.