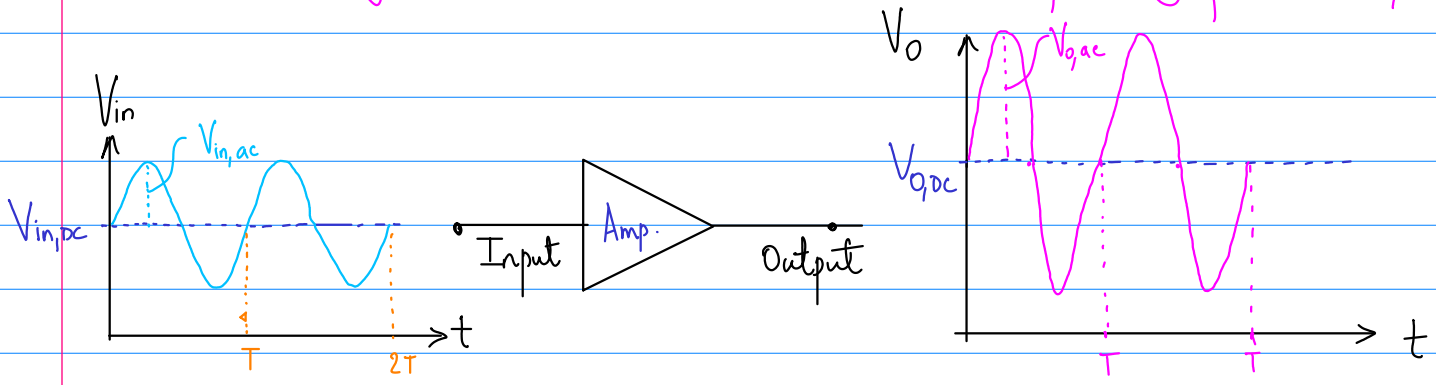
22.02.2022

BJT Amplifiers

(Small Signal Amplifiers)

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



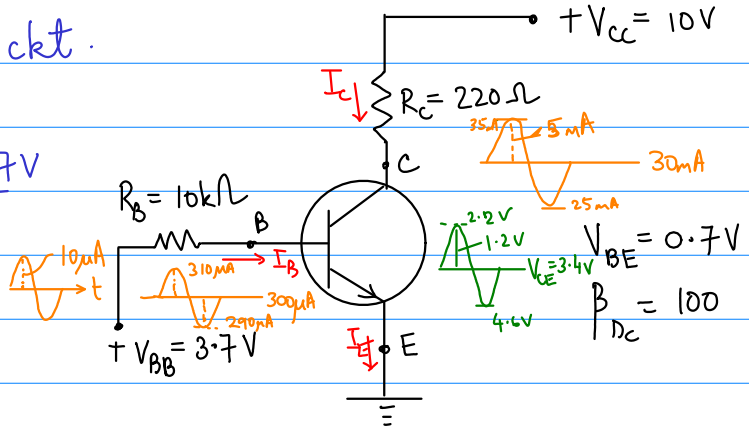
$V_{o,ac} \gg V_{in,ac}$ whereas $T_{out} = T_{in}$

Small-Signal Amplifiers:

- Variation about the set Q-point is relatively small.

(case(i)) Q-point is set nearly in the middle of the load-line.

For the given biased BJT ckt.



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

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

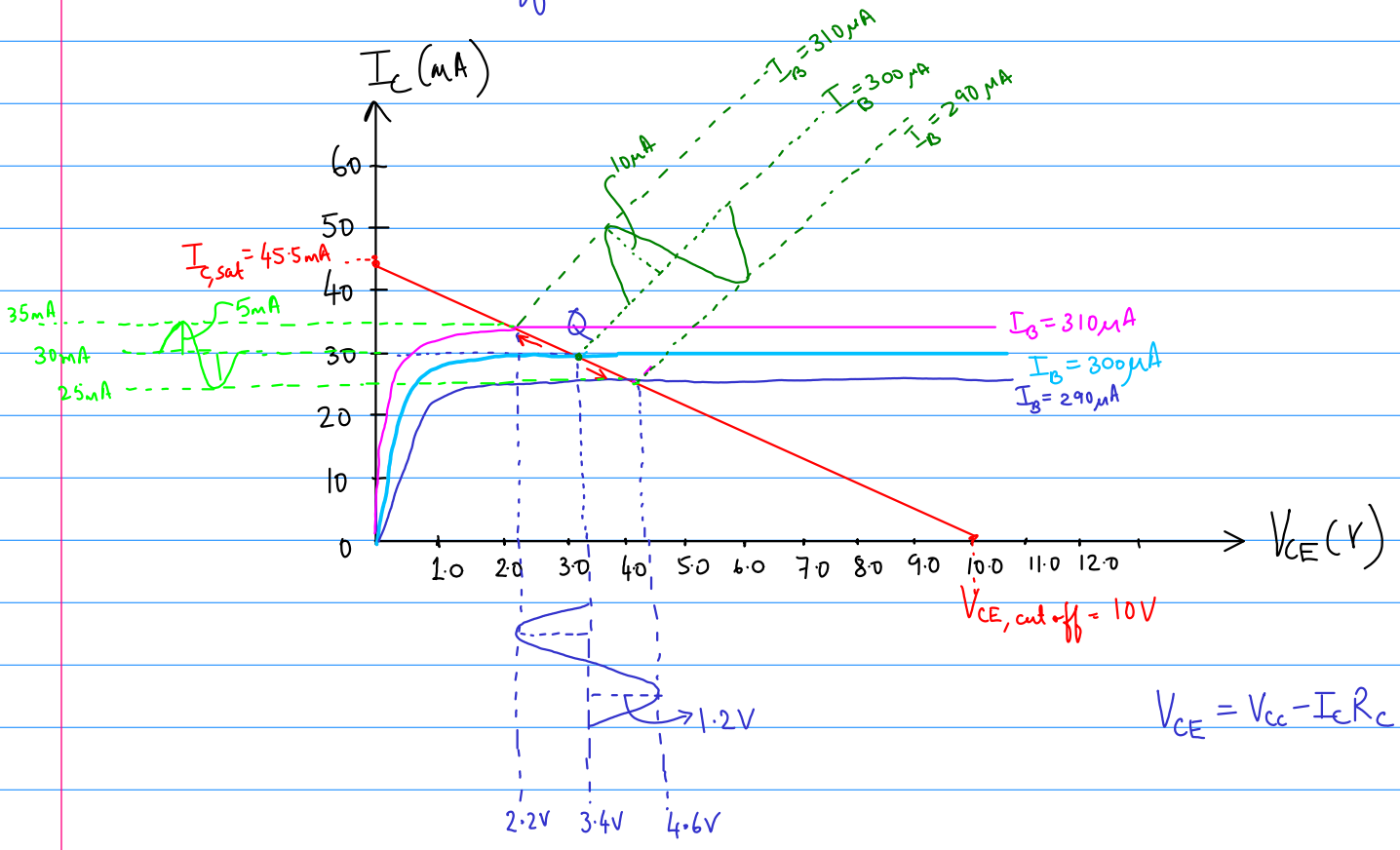
$$I_C = \beta_{DC} I_B = 100 \times 300\mu A = 30mA$$

$$V_{CE} = V_{CC} - I_C R_C = 10V - 30mA \times 220\Omega = 3.4\,V$$

Q-point : $V_{CE}, I_C \Rightarrow 3.4\,V, 30mA$

$$I_{c,sat} = \frac{V_{cc}}{R_c} = \frac{10V}{220\Omega} = 45.5mA$$

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



$$V_{CE} = V_{cc} - I_c R_c$$

Look at the amplitude of the ac base-current = $10\mu A$

Amplitude of the ac collector-current = $5mA$

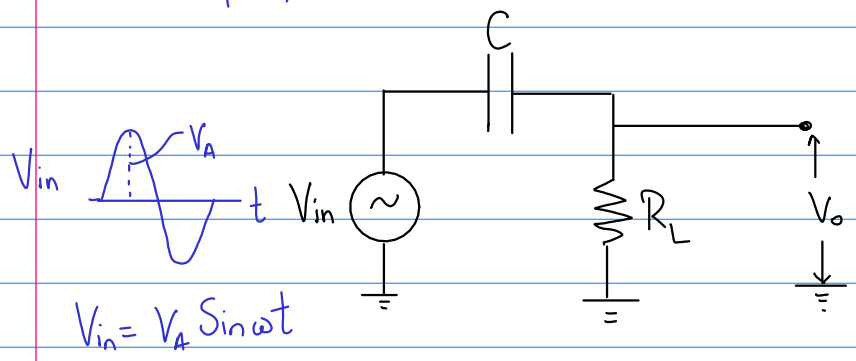
$$\text{Current Gain} = \frac{\text{Amp. of Collector-Current}}{\text{Amp. of Base-Current}}$$

$$= \frac{5mA}{10\mu A} = 500$$

$\Rightarrow$ The input signal strength is enhanced by 500 times.

How do we couple ac-signal with the DC current/voltage?

To perfor this task, we make use of the "Coupling Capacitor"



We know that, the capacitor reacts to the ac-signals.

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

Case(i)

$$\Rightarrow \quad X_C \propto \frac{1}{\omega}$$

Let $\omega \longrightarrow 0$ (dc signal)

$$X_C \longrightarrow \infty$$

$\Rightarrow$ the capacitor is "OPEN-CIRCUITED"

Case(ii)

$\omega \longrightarrow \infty$ (High-frequency)

$$X_C \longrightarrow 0$$

$\Rightarrow$ the capacitor behaves as "SHORT-CIRCUITED"

From the above discussion, we concluded that the capacitor is "OPEN" for DC signals and "SHORT" for ac signals

when $\boxed{R_L \geq 10 X_C}$ then the entire ac-signal will be available at R_L.

– Condition for a good Coupling.

Ckt design of a simple amplifier ckt using BJT.