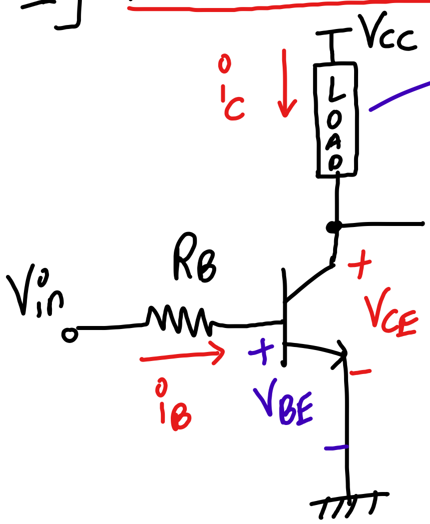
EEEE BJT applications

12/11/23

I] BJT as a Electronics Switch :



load can be a motor or a LED

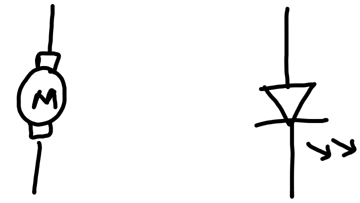


fig1 : npn bjt used as a switch

① npn bjt in the circuit is switched between cut-off and saturation region

② bjt can be used to switch currents, voltages & power

$$\boxed{V_{BE(on)} = 0.7V}$$

③ If $V_{in} < V_{BE(ON)} \longrightarrow i_B = i_C = 0$

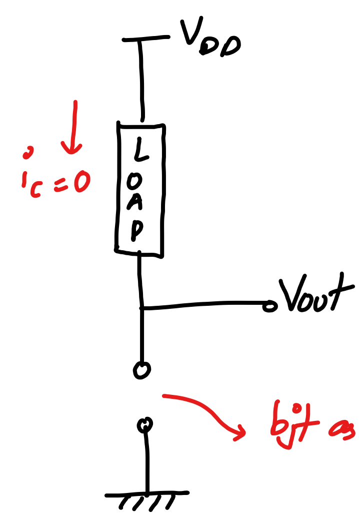
a) npn bjt is in cut-off mode

b) $V_{out} = V_{cc}$

c) Power dissipation $P_D \simeq 0$

d) If load is a motor → motor would be off with zero current

e) If load is a LED → Light output will be zero with zero current



bjt as open switch

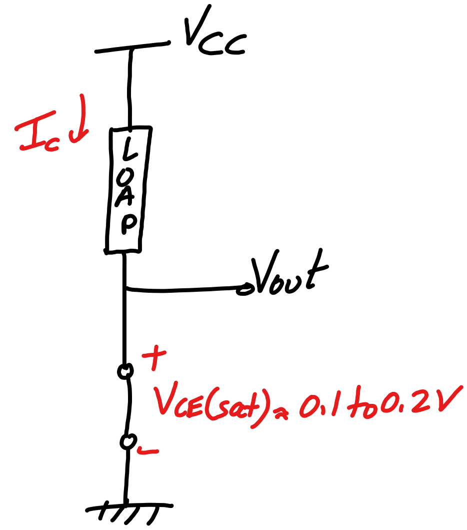
④ If $V_{in} = V_{cc}$ → npn bjt is usually driven into saturation region

From fig1, $i_B = \dfrac{V_{in} - V_{BE(ON)}}{R_B}$

$$i_C = I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C}$$

$$V_{out} = V_{CE(sat)}$$

very low value (0.1 to 0.2V)

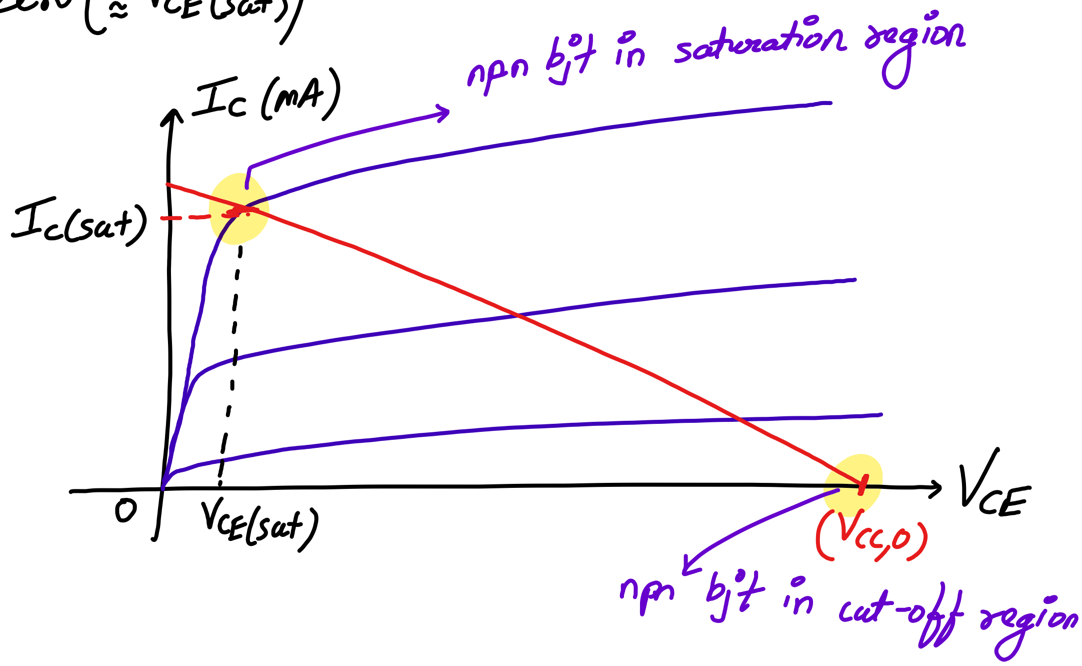


5. I_C is induced that would turn 'ON' the motor or LED — depending upon the type of load

6. Assumption: $V_{BE(on)} \approx 0.7V$

7. Note: a) V_{CE} when npn bjt is in cut-off region is V_{CC}

   b) V_{CE} when npn bjt is in saturation region is almost zero ($\approx V_{CE(sat)}$)



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* BJT as a amplifier :

$$\text{Voltage gain} = \frac{\text{O/P swing}}{\text{I/P swing}} = A_V$$

① For npn bjt to operate as an amplifier following condition's is to be met :

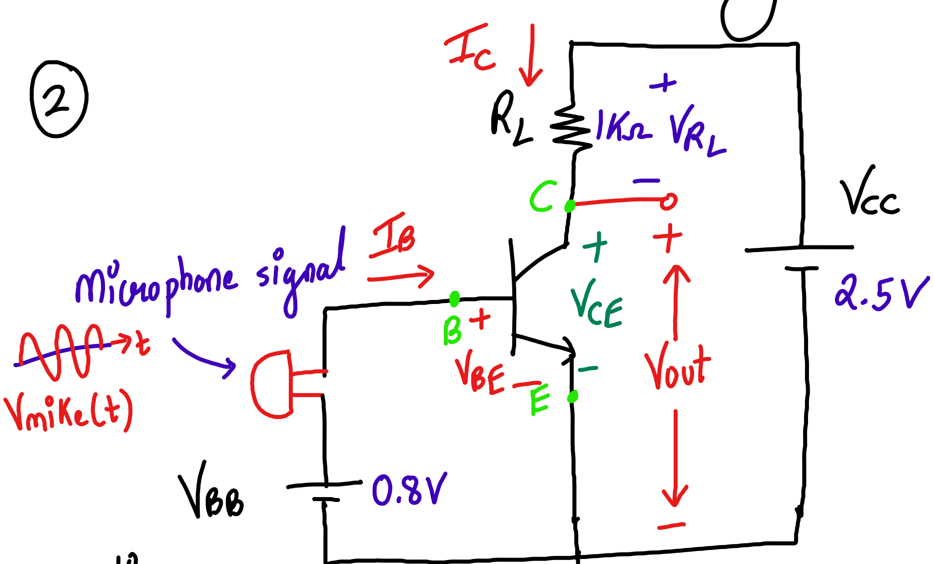
a) Create proper biasing condition for transistor

i.e npn bjt operating in active region

i.e B-E J^n : F.B

& B-C J^n : R.B

b) Apply small time-varying input signal

② 

fig(a) : BJT as a amplifier

$I_C = \beta I_B$

say $\beta = 100$ → "Current gain"

$I_B = 0.01mA$

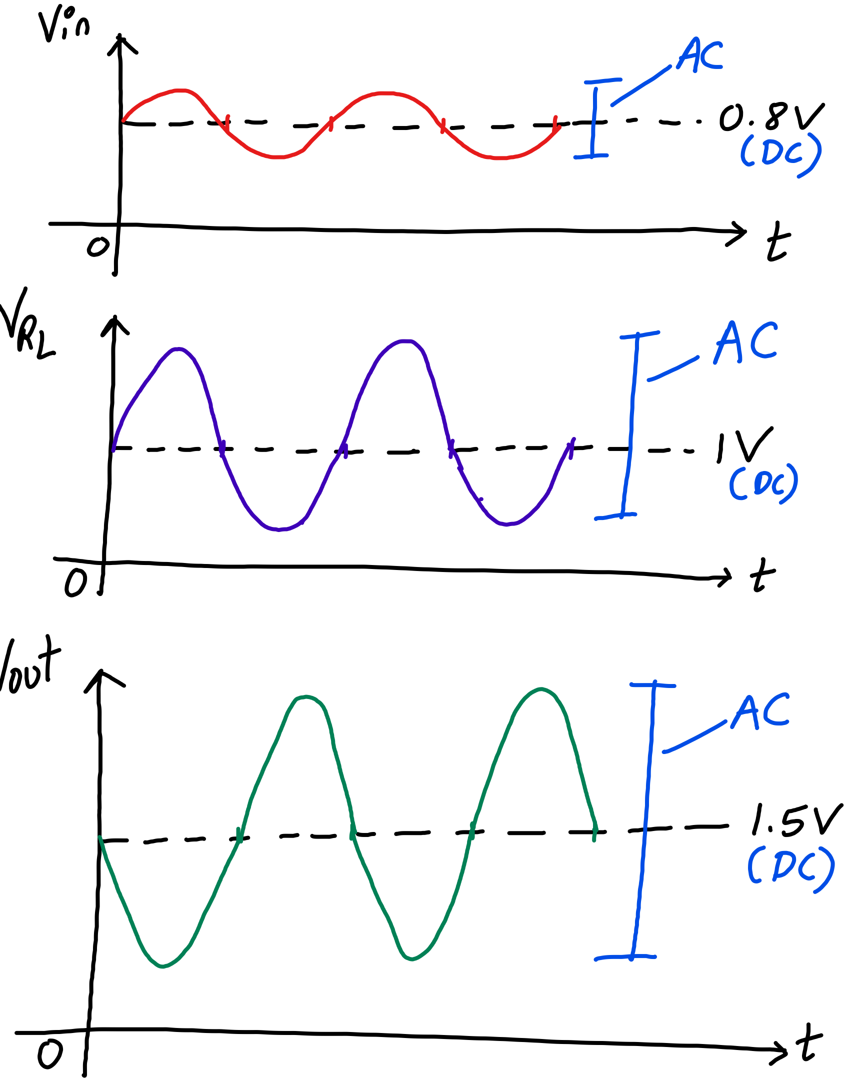
$I_C = 0.01mA \times 100$

$\boxed{I_C = 1mA}$

$V_{R_L} = R_L I_C = 1K \times 1mA = 1V$

$V_{CE} = V_{out} = V_{CC} - R_L I_C = 2.5V - 1V = 1.5V$

$V_{in} = V_{BB} + V_{mike}$



③ By observing Vout waveforms, output is amplified version of input

④ In this way, npn bjt behaves as an amplifier

⑤ From fig(a), $V_{CC} = V_{R_L} + V_{CE}$

$V_{CE} = V_{CC} - V_{R_L}$

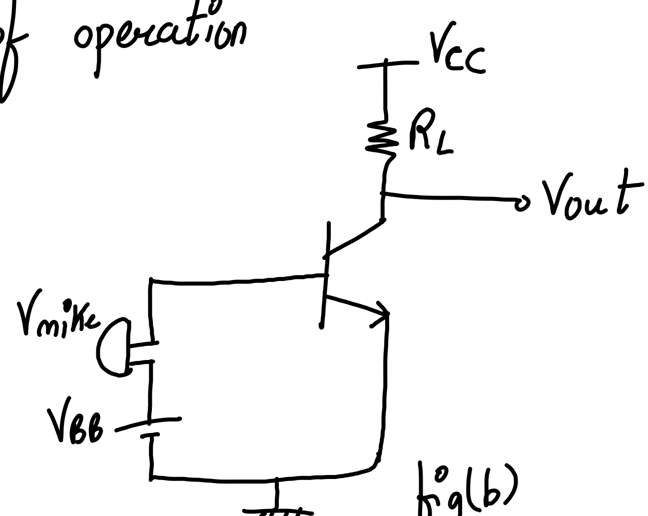
$= 2.5 - 1$

$V_{CE} = 1.5V$

⑥ Thus, $V_{BB} = 1V$ & $V_{CE} = 1.5V$ ensure that BE J^n is F.B and BC J^n is R.B

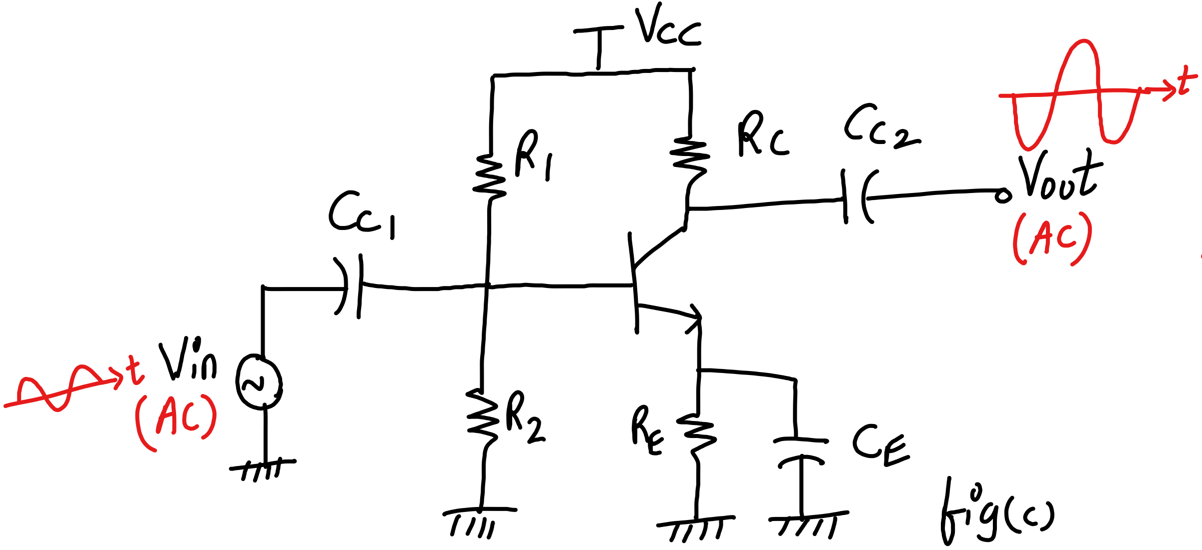
i.e npn bjt is in active region of operation

⑦ Simplified diagram for fig (a)



fig(b)

⑧ In reality, voltage divider biasing is used for BJT to work as an amplifier (fig c)



fig(c)

C_{c_1} & C_{c_2} → They will block DC & allow AC signals to pass through

C_E : bypass capacitor → allow ac signal to flow through it & bypass R_E

R_1 & R_2 : Voltage divider bias arrangement → provide voltage at base terminal from Vcc

i.e $V_B = \frac{R_2}{R_1+R_2} V_{cc}$ → V_B is fraction of V_{cc}

⑨ Voltage divider bias ($R_1 - R_2$) & V_{cc} will make sure that npn bjt operates in active region of operation.

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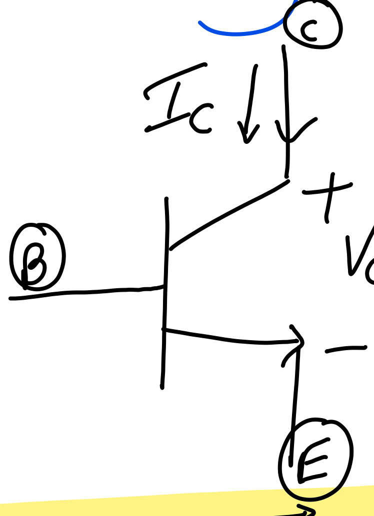
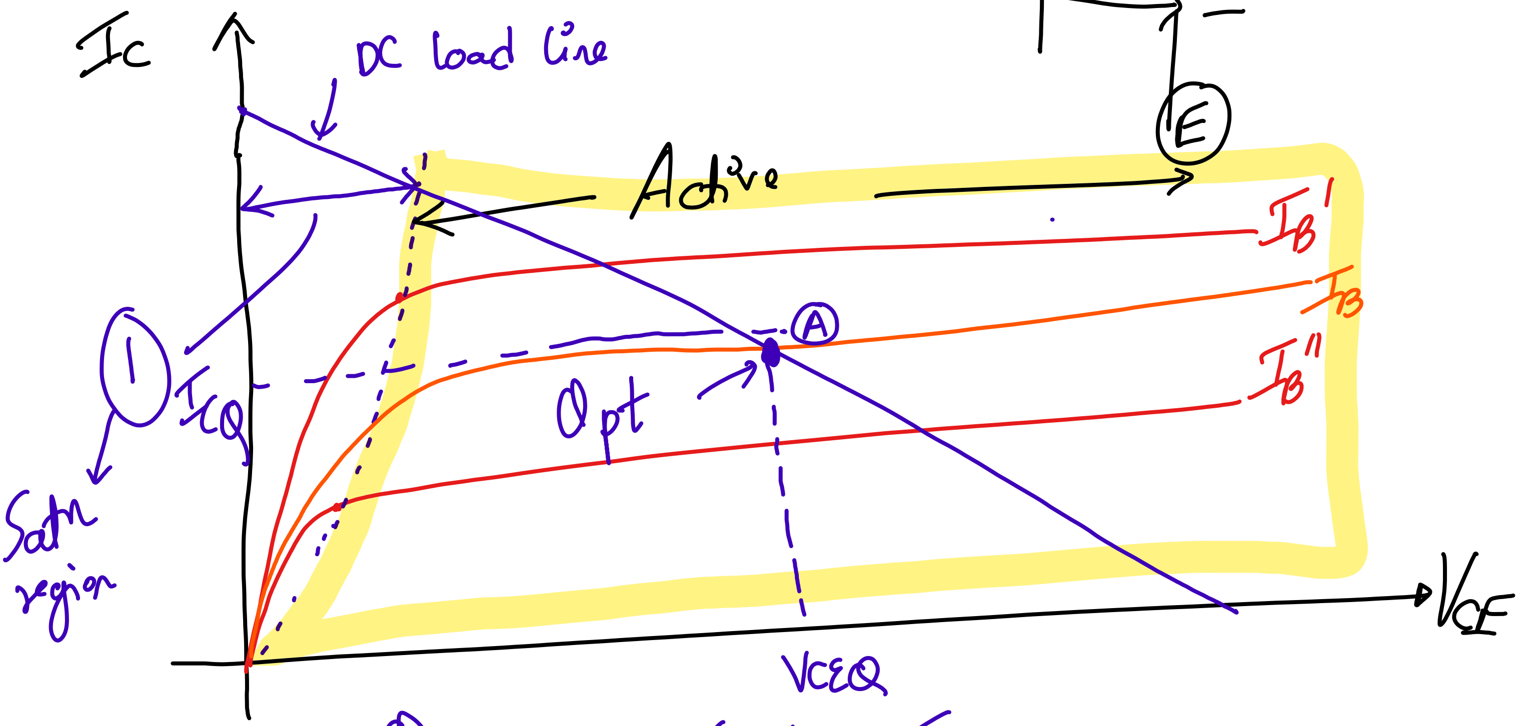
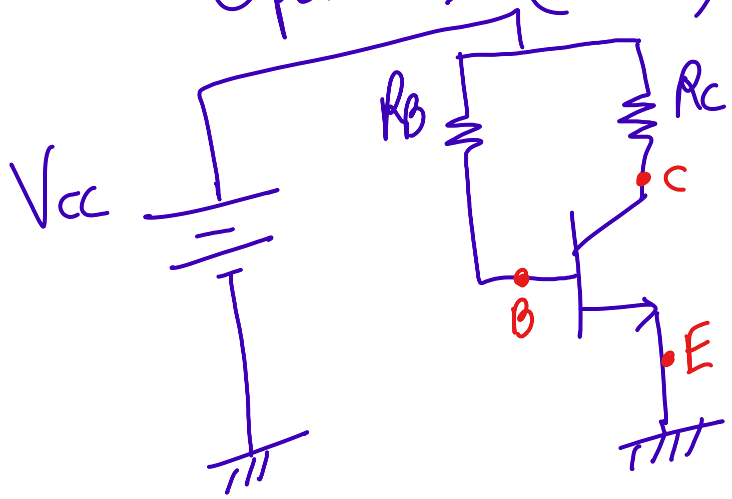
DC biasing in BJT, Operating Point

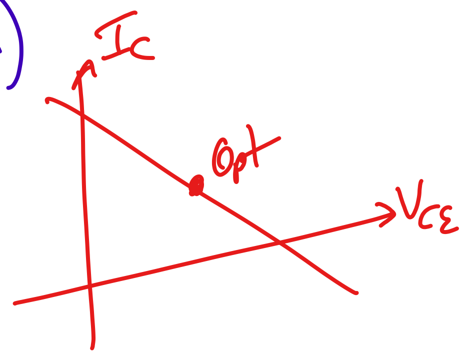
BJT DC biasing: 'V_{CE}' & 'I_C'





$$Q\text{point} \equiv (V_{CEQ}, I_{CQ})$$





Fixed bias BJT ckt