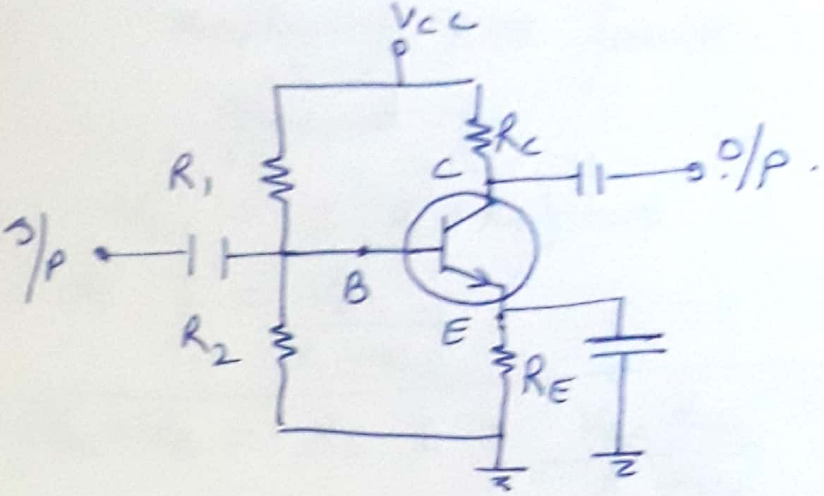
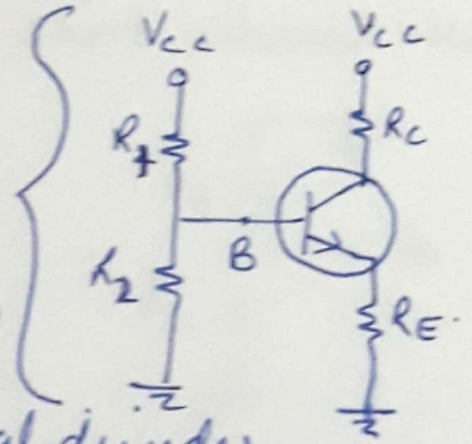
Voltage Divider Bias

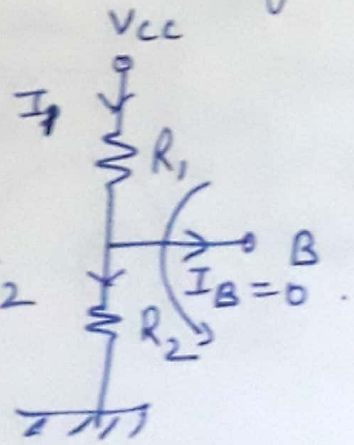


It can be simplified as:-



Potential divider

We make equivalent circuit of the potential divider by using Thevenin's theorem.



To find Equivalent Voltage (Thevenin Voltage) at Base. (V_{th})

(we open circuit the o/p)

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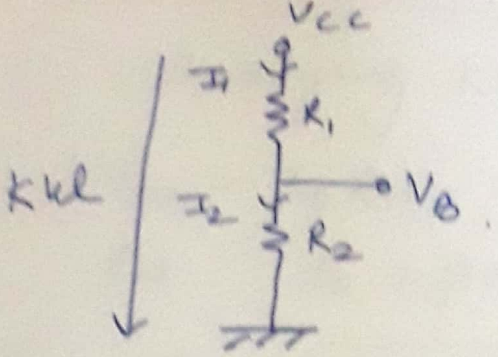


$\because \; I_B = 0$

$\Rightarrow \; I_1 = I_2 = I$

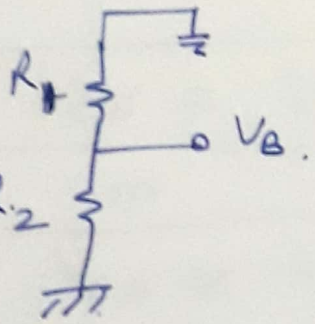
Applying KVL from Vcc to ground.

$$V_{CC} - I(R_1 + R_2) = 0$$

$$\Rightarrow I = \frac{V_{CC}}{R_1 + R_2}$$

and $\boxed{V_{th} = V_B = R_2 \cdot I = \frac{V_{CC} R_2}{R_1 + R_2}}$.

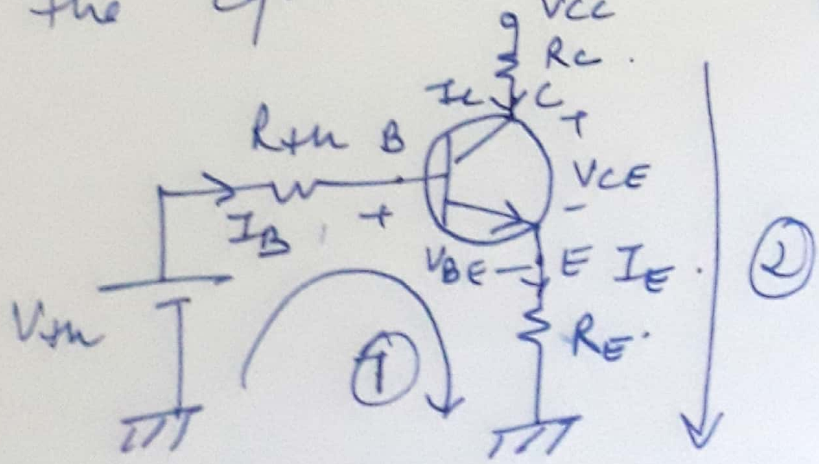
To find Equivalent Resistance (R_{th}).
(we short circuit the Voltage source)



R_1 and R_2 becomes in parallel.

$$\Rightarrow R_{th} = \frac{R_1 R_2}{R_1 + R_2}.$$

Now the Equivalent circuit of the VDB will be.



Applying KVL in loop ①

$V_{th} - I_B R_{th} - V_{BE} - I_E R_E = 0$.

Put $I_E = (\beta+1) I_B$.

① $\Rightarrow$ $$\boxed{I_B = \frac{V_{th} - V_{BE}}{R_{th} + (\beta+1) R_E}}$$

② $$\boxed{\begin{aligned} I_C &= \beta I_B \\ I_E &= (\beta+1) I_B \end{aligned}}$$

③ Applying KVL in loop ②

$V_{CC} - I_C R_C - V_{CE} - I_E R_E = 0$

$\Rightarrow$ $$\boxed{V_{CE} = V_{CC} - I_C R_C - I_E R_E}$$

or

$$\boxed{V_{CE} \simeq V_{CC} - I_C (R_C + R_E)}$$