9. Transistor Amplifying Action, Relation b/w a and B

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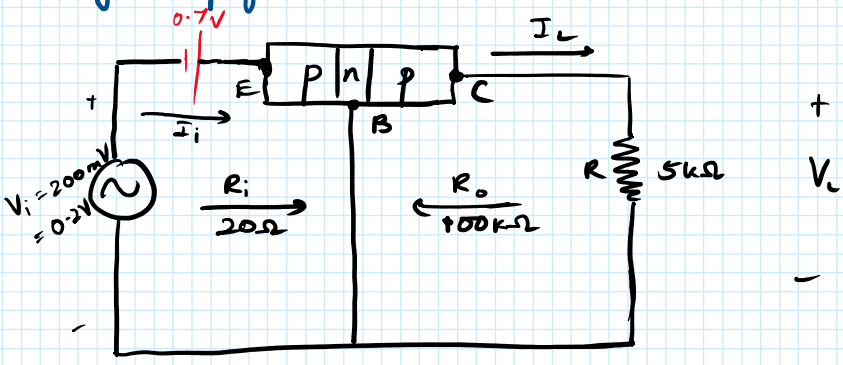
Transistor Amplifying Action – Common Base

Voltage amplification → denoted as A_v



$$I_i = \frac{V_i}{R_i} = \frac{200\,mV}{20\,\Omega} = 10\,mA$$

If we assume $\alpha_{ac} = 1$ $(I_c = I_e)$,

$$I_L = I_i = 10\,mA$$

$$V_L = I_L R$$

$$= (10\,mA)(5k\Omega)$$

$$= 50\,V$$

Voltage amplification A_v

$$A_v = \frac{V_L}{V_i} = \frac{50\,V}{200 \times 10^{-3}} = 0.25 \times 10^3 = 250$$

→ range: (50-300)

Q. For the previous problem, if the input voltage is changed to 500 mV and the collector load is 1 kΩ, assuming all other parameters are the same, find the output voltage and the voltage amplification.

Soln. $I_i = \frac{500\,mV}{20\,\Omega} = 25\,mV$

Assuming $\alpha = 1$

$$I_L = I_i = 25\,mV$$

$$V_L = I_L R$$

$$= (25\,mV)(1k\Omega)$$

$$= 25\,V$$

Voltage amplification A_V

$$A_V = \frac{V_L}{V_i} = \frac{25}{500\,mV} = 0.05 \times 10^3 = 500$$

RELATION BETWEEN α AND β

w.k.t

$$\beta = \frac{I_C}{I_B}, \quad \alpha = \frac{I_C}{I_E}$$

$$\Rightarrow I_B = \frac{I_C}{\beta}, \quad I_E = \frac{I_C}{\alpha}$$

Total current

$$I_E = I_C + I_B$$

Substituting,

$$\frac{I_C}{\alpha} = I_C + \frac{I_C}{\beta}$$

Dividing by I_C

$$\frac{1}{\alpha} = 1 + \frac{1}{\beta} \quad \Rightarrow \quad \frac{1}{\beta} = \frac{1}{\alpha} - 1$$

$$\boxed{\alpha = \frac{\beta}{\beta+1}} \qquad \boxed{\beta = \frac{\alpha}{\alpha-1}}$$