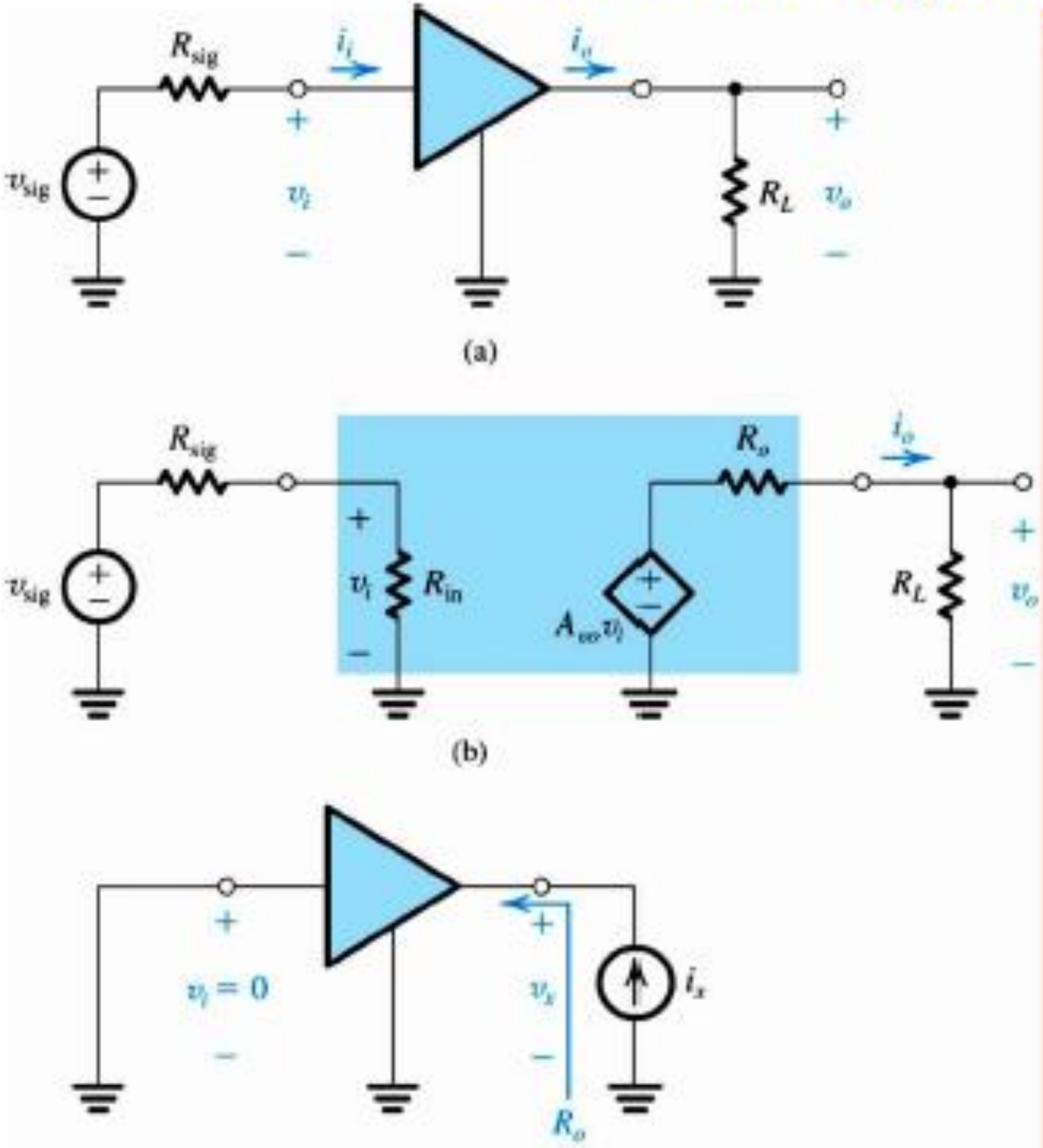
Lec-8

Characterizing Amplifiers



(a)

(b)

(c)

$$R_{in} \equiv \frac{v_i}{i_i} \qquad v_i = \frac{R_{in}}{R_{in} + R_{sig}} v_{sig}$$

$$A_{vo} \equiv \left.\frac{v_o}{v_i}\right|_{R_L = \infty} \qquad R_o = \frac{v_x}{i_x}$$

$$v_o = \frac{R_L}{R_L + R_o} A_{vo} v_i$$

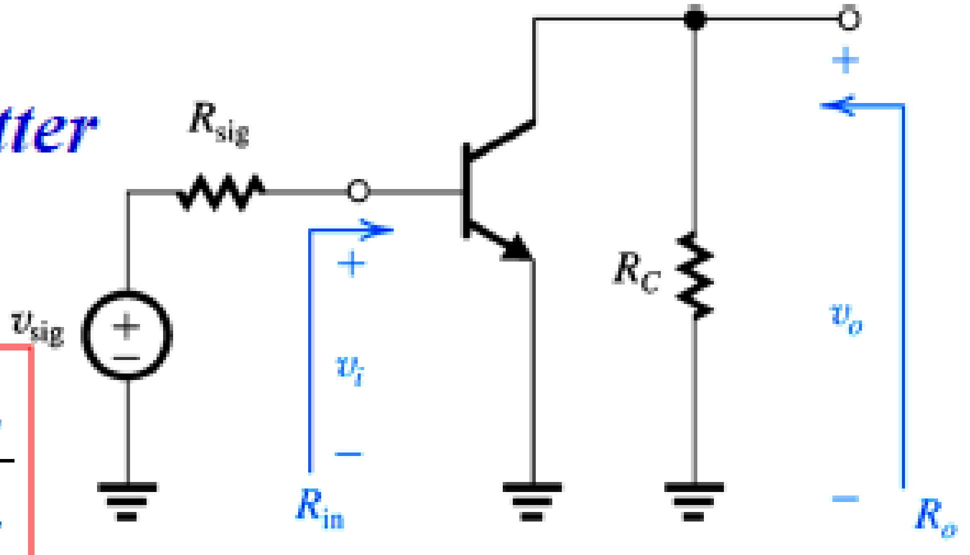
$$A_v \equiv \frac{v_o}{v_i} = A_{vo} \frac{R_L}{R_L + R_o}$$

$$G_v \equiv \frac{v_o}{v_{sig}} \qquad G_v = \frac{R_{in}}{R_{in} + R_{sig}} A_v$$

The Common-Emitter (CE) Amplifier

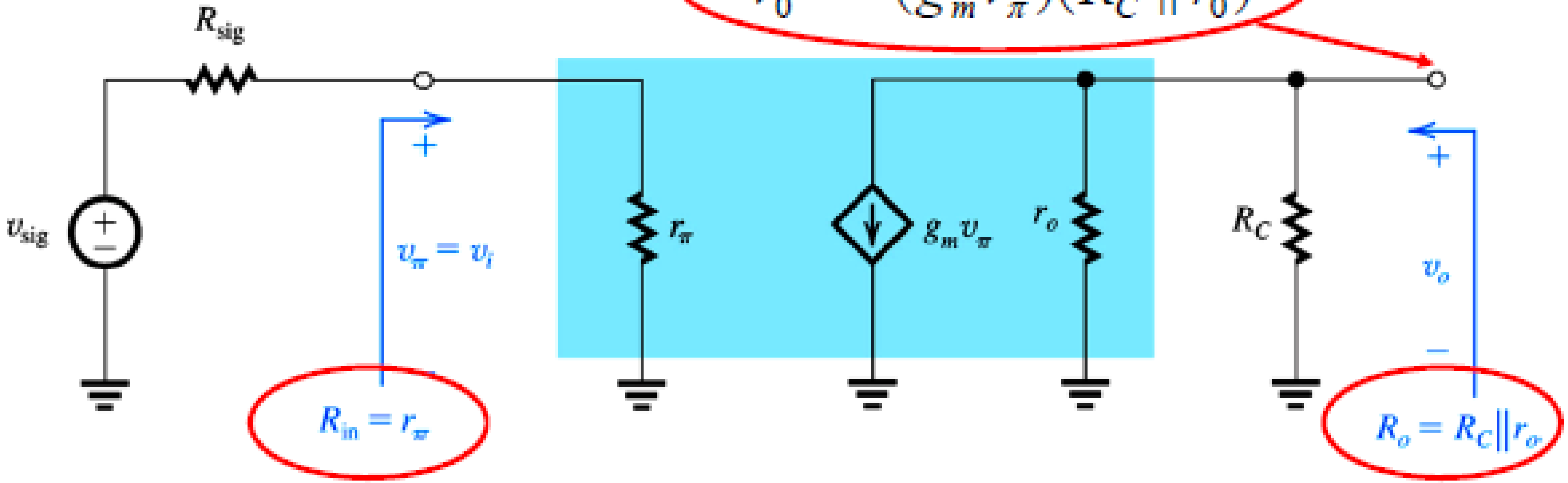
$$r_\pi = \frac{\beta}{g_m} \qquad g_m = \frac{I_C}{V_T}$$

$$r_O = |V_A| / I_C$$

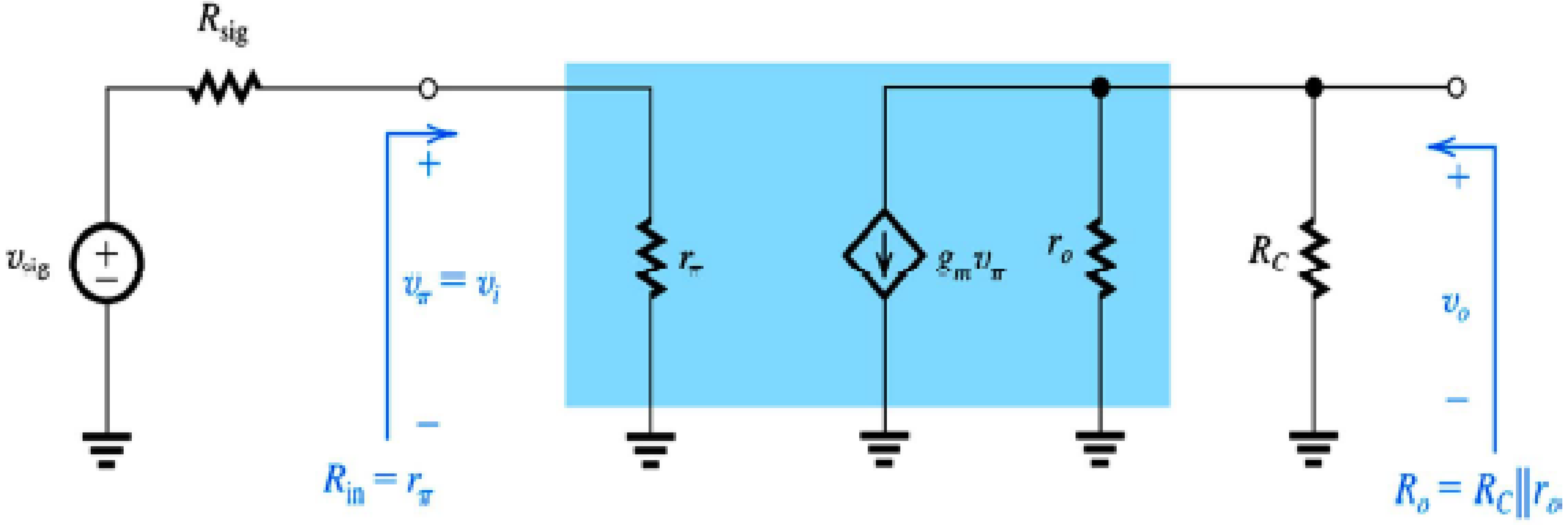


(a)

$$v_0 = -(g_m v_\pi)(R_C \parallel r_0)$$



(b)



(b)

$$v_i = v_\pi \qquad A_{v0} \equiv \frac{v_0}{v_i}$$

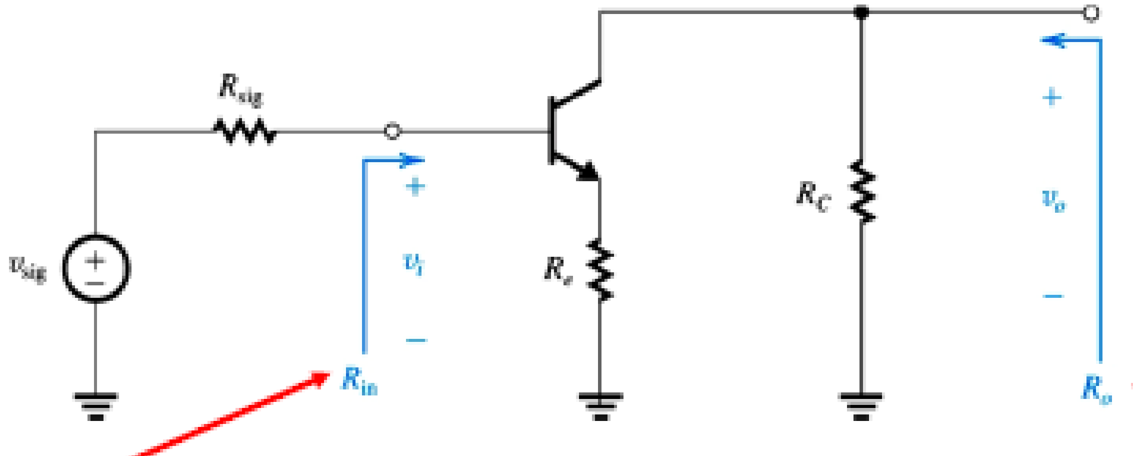
$$A_v = -g_m (R_C \parallel R_L \parallel r_0)$$

$$A_{v0} = -g_m (R_C \parallel r_0)$$

$$G_v \equiv \frac{v_0}{v_{sig}} = -\frac{r_\pi}{r_\pi + R_{sig}} g_m (R_C \parallel R_L \parallel r_0)$$

$$R_0 \approx R_C \qquad (r_0 \text{ is large})$$

CE amplifier with an emitter resistance Re

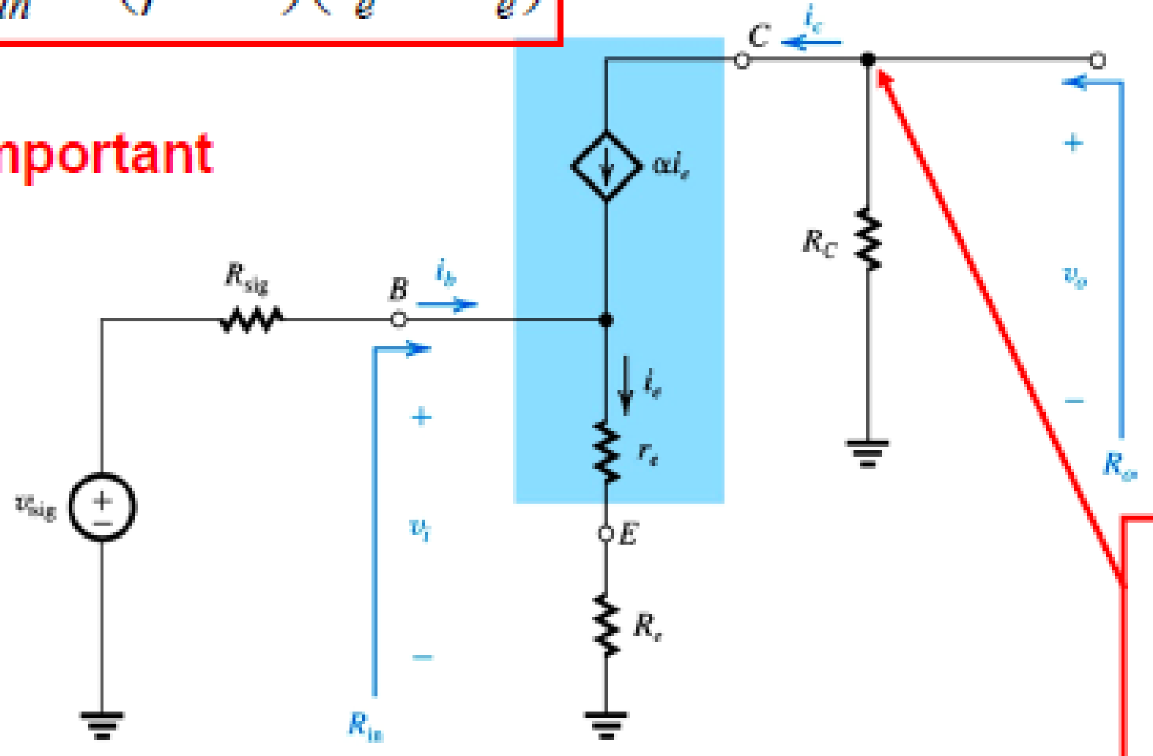


(a)

$$R_o = R_C$$

$$R_{in} = (\beta+1)(r_e + R_e)$$

important

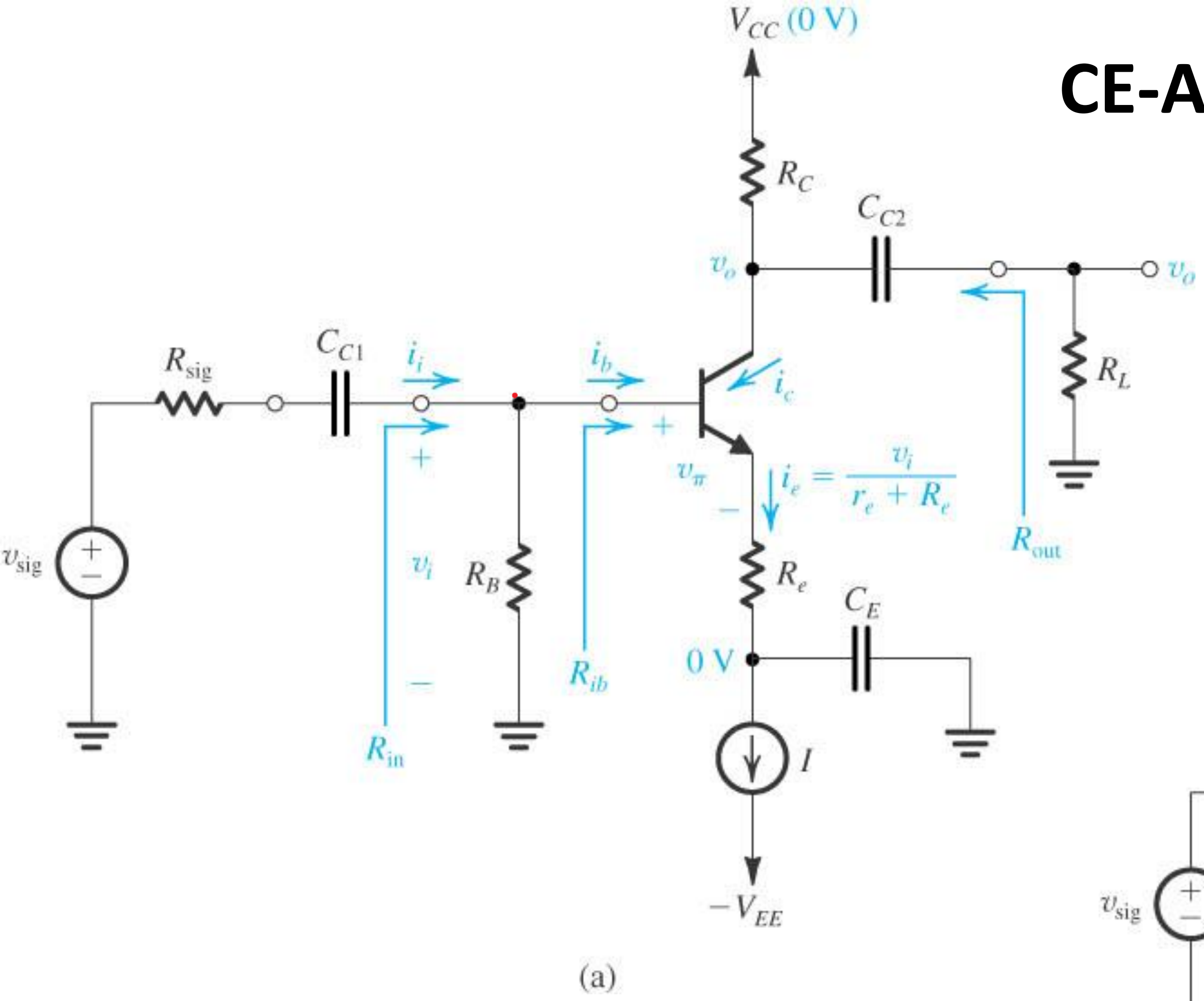


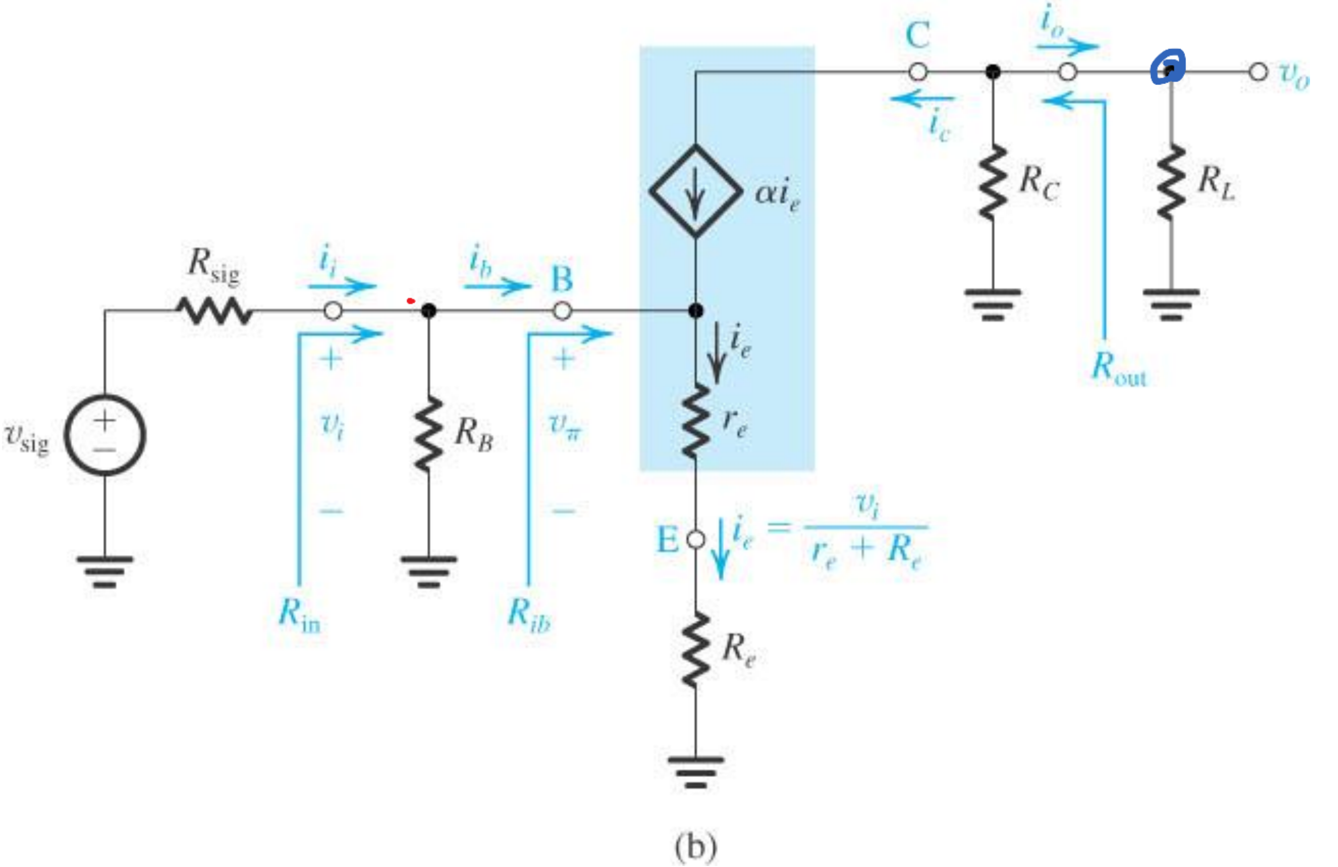
(b)

$$A_{vo} = -\frac{g_m R_C}{1+\dfrac{R_e}{r_e}} \cong -\frac{g_m R_C}{1+g_m R_e}$$

Lec-9

CE-AMP. using Current Source Biasing





H.W. (self study)

Obtain R_{in}, R_{out} and A_{vo}

Review concepts to analyse any amplifier configuration

- External Capacitors (µF) are used to couple AC input signal/ DC blocking/ Bypass capacitor.
- For DC- these are assumed to be open ckt for DC analysis.
- To be considered as short ckt for AC analysis i.e. Small Signal Analysis for Mid frequency band (kHz).
- Internal Device capacitors (pF) also assumed open ckt.

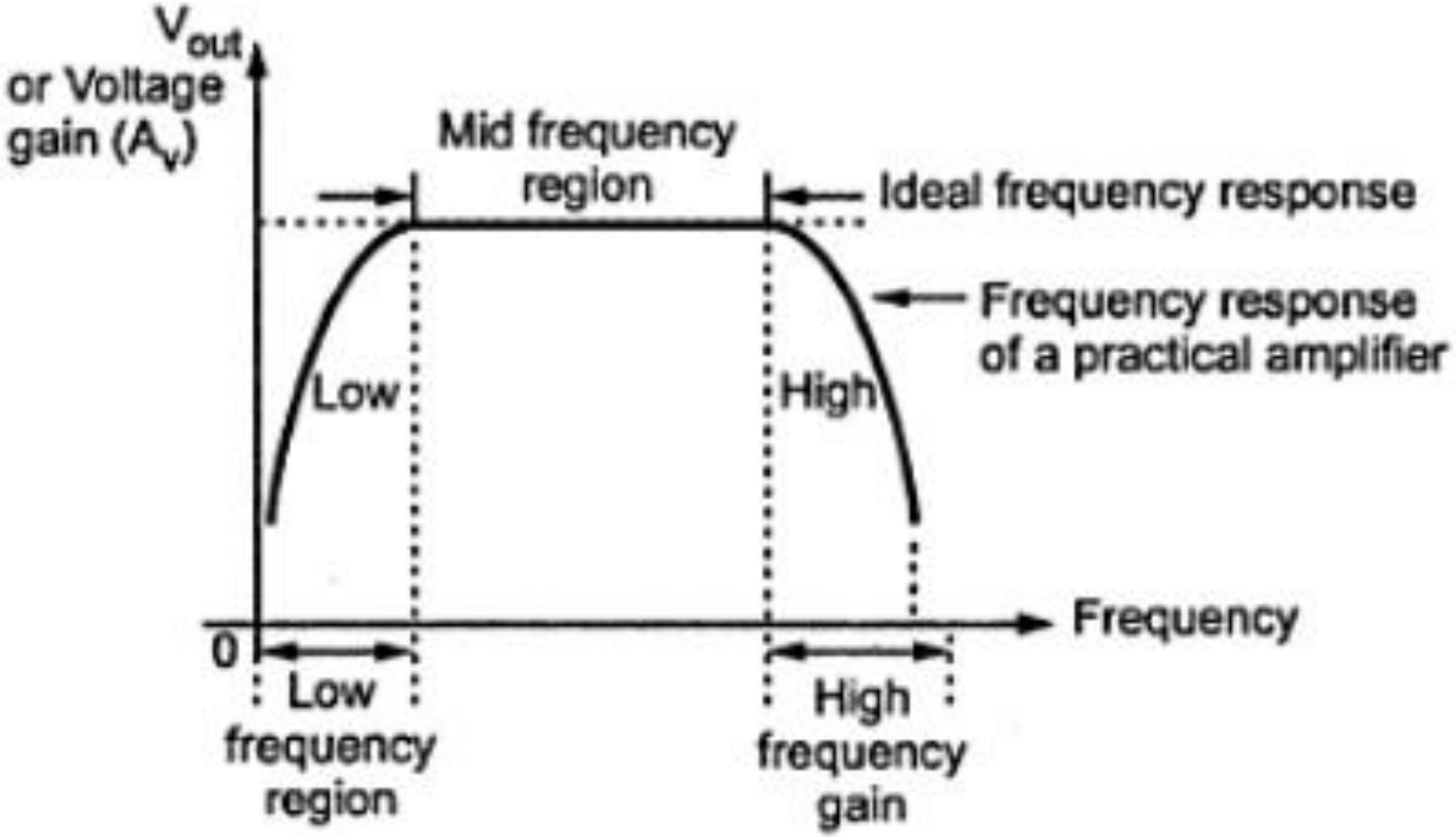
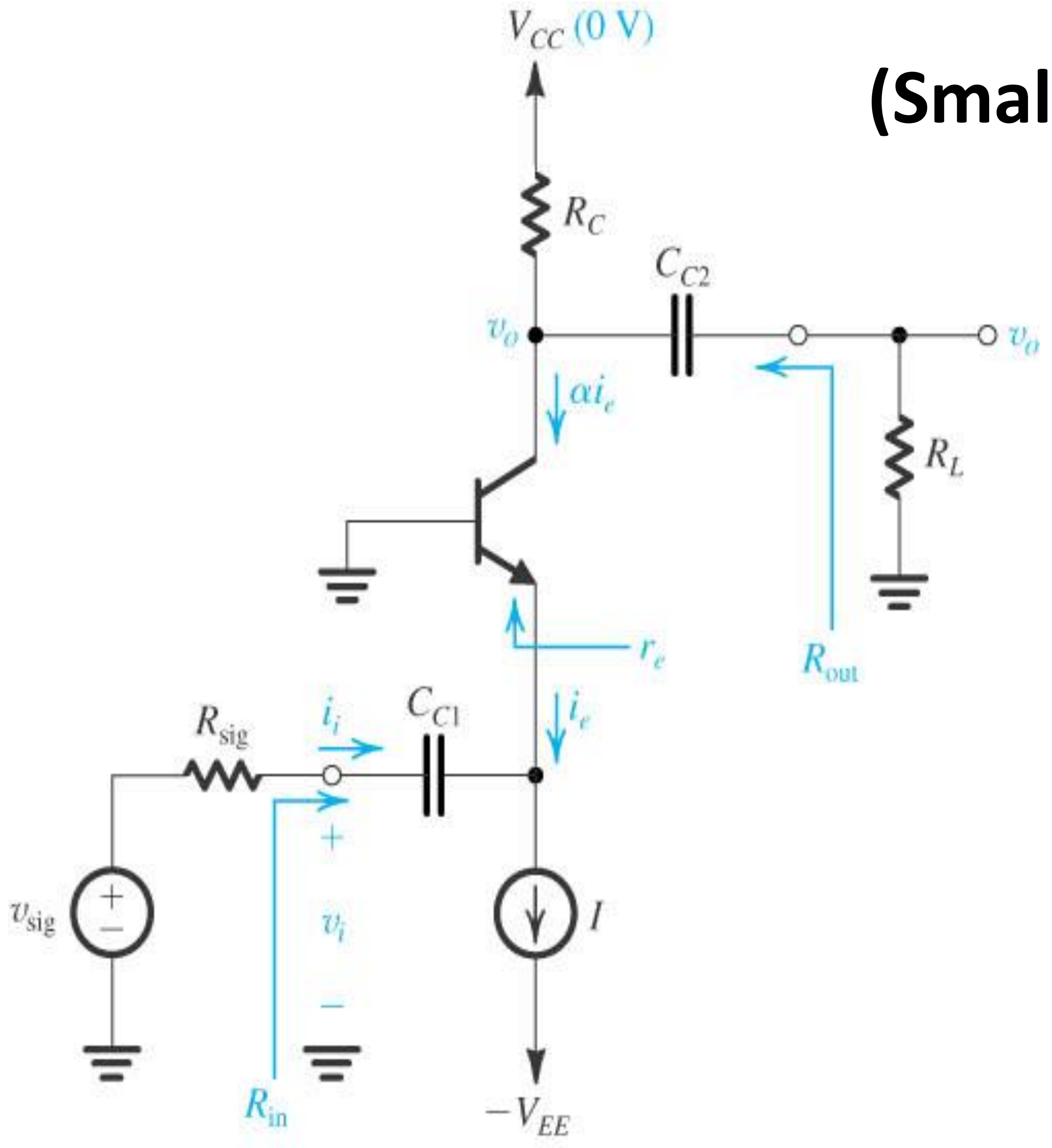


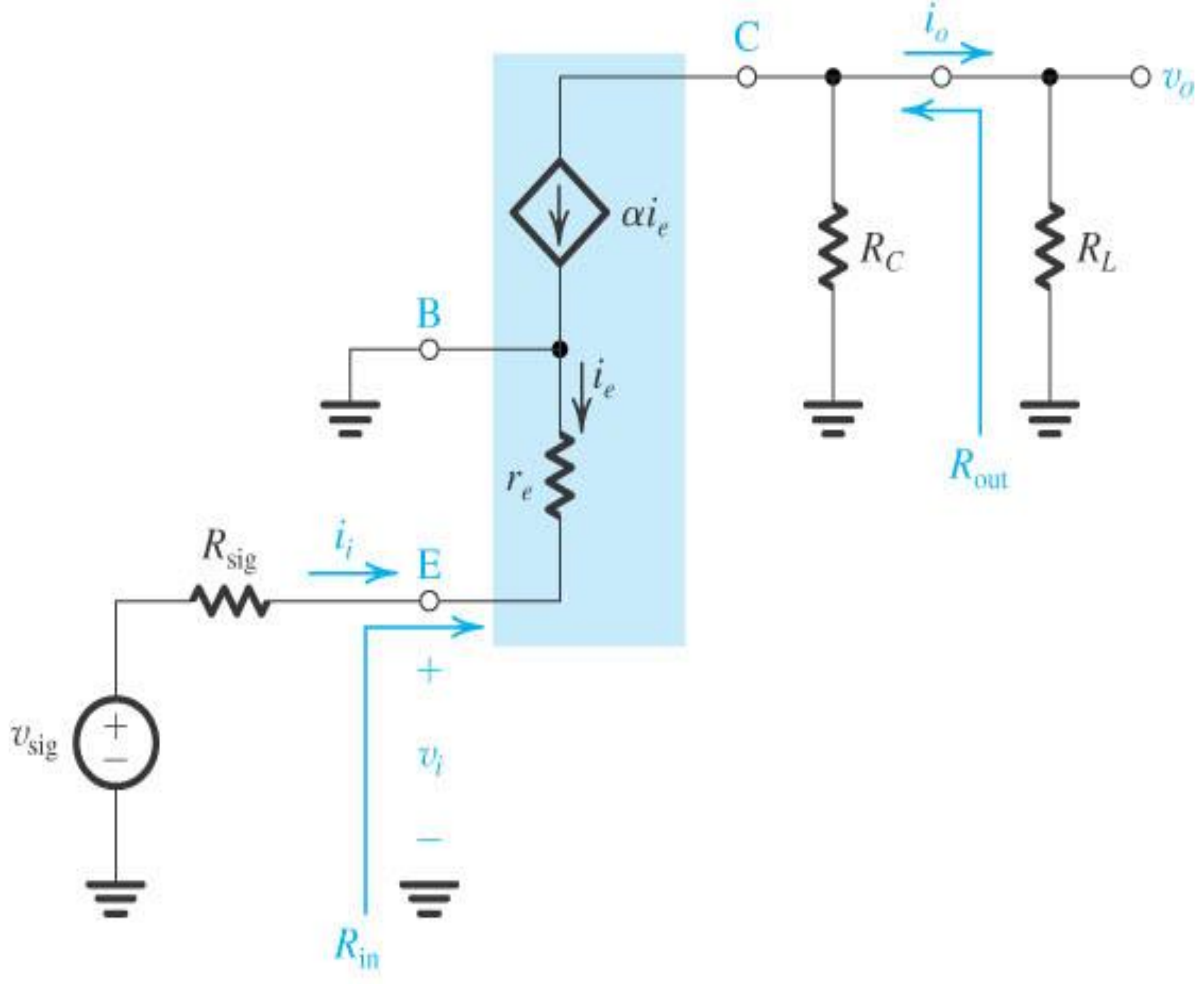
Fig. A typical frequency response of an amplifier

Common Base and Common Collector Amp.
Small Signal -AC analysis

CB-Amplifier
(Small Signal AC analysis)

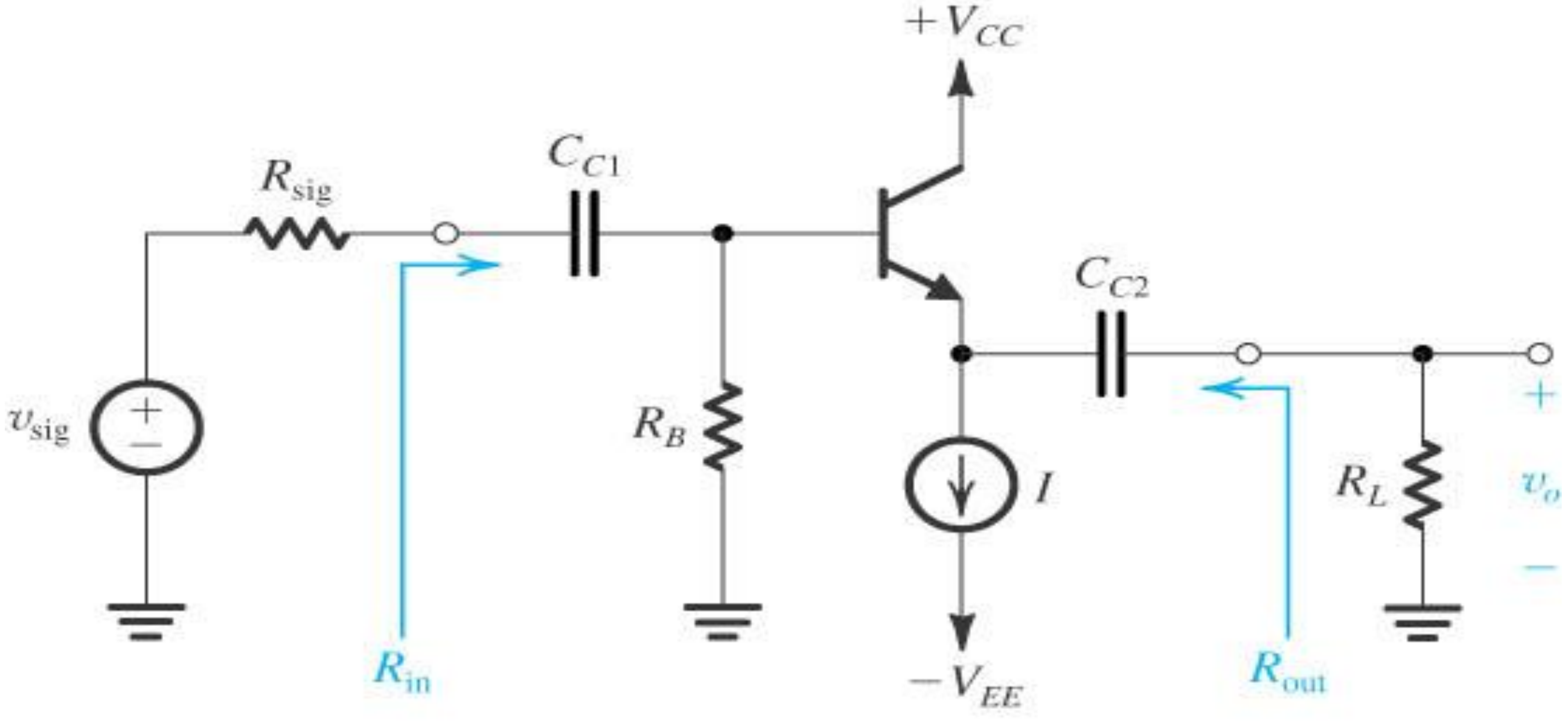


(a)



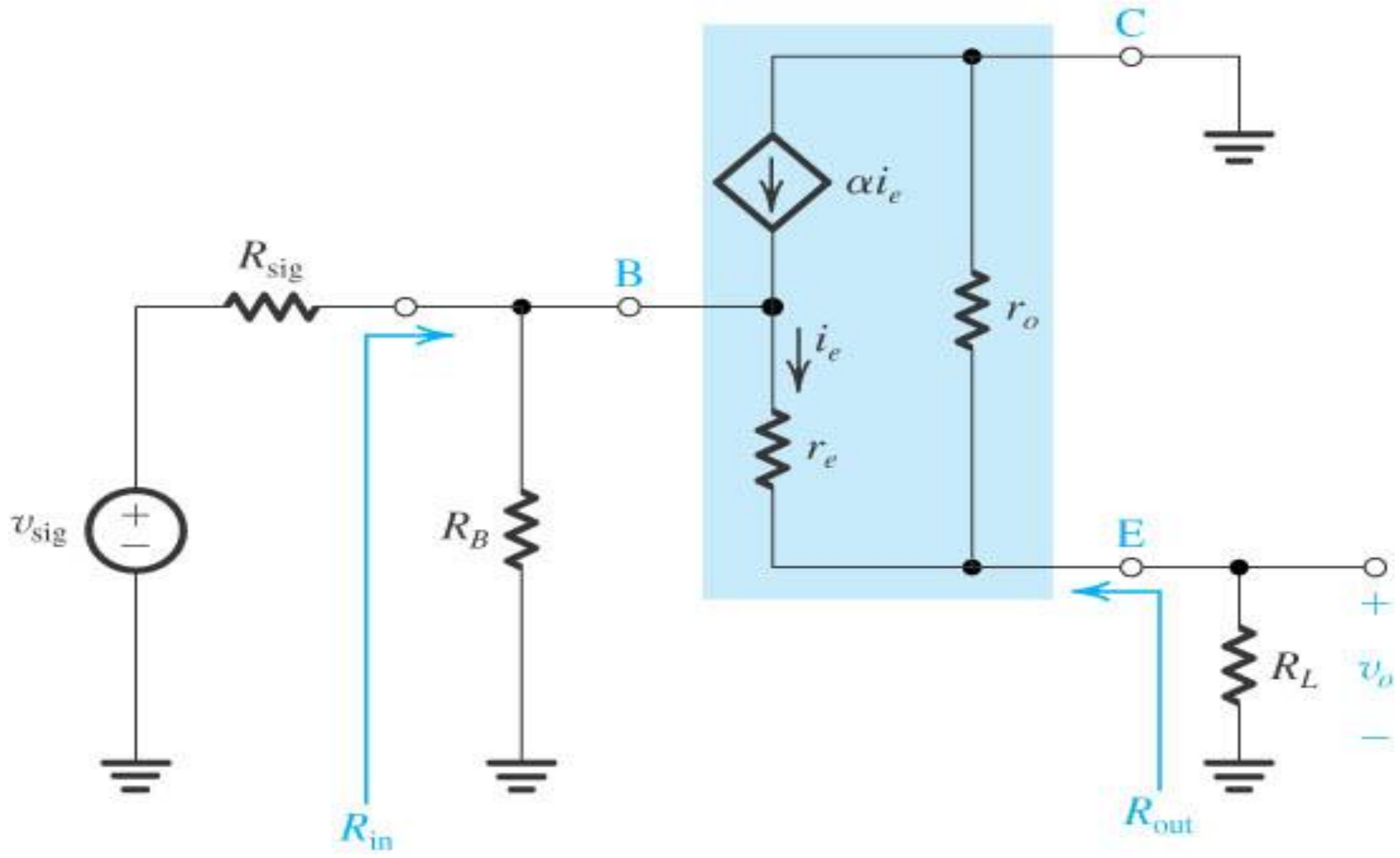
(b)

CC-Amplifier/Emitter Follower/ Voltage Buffer

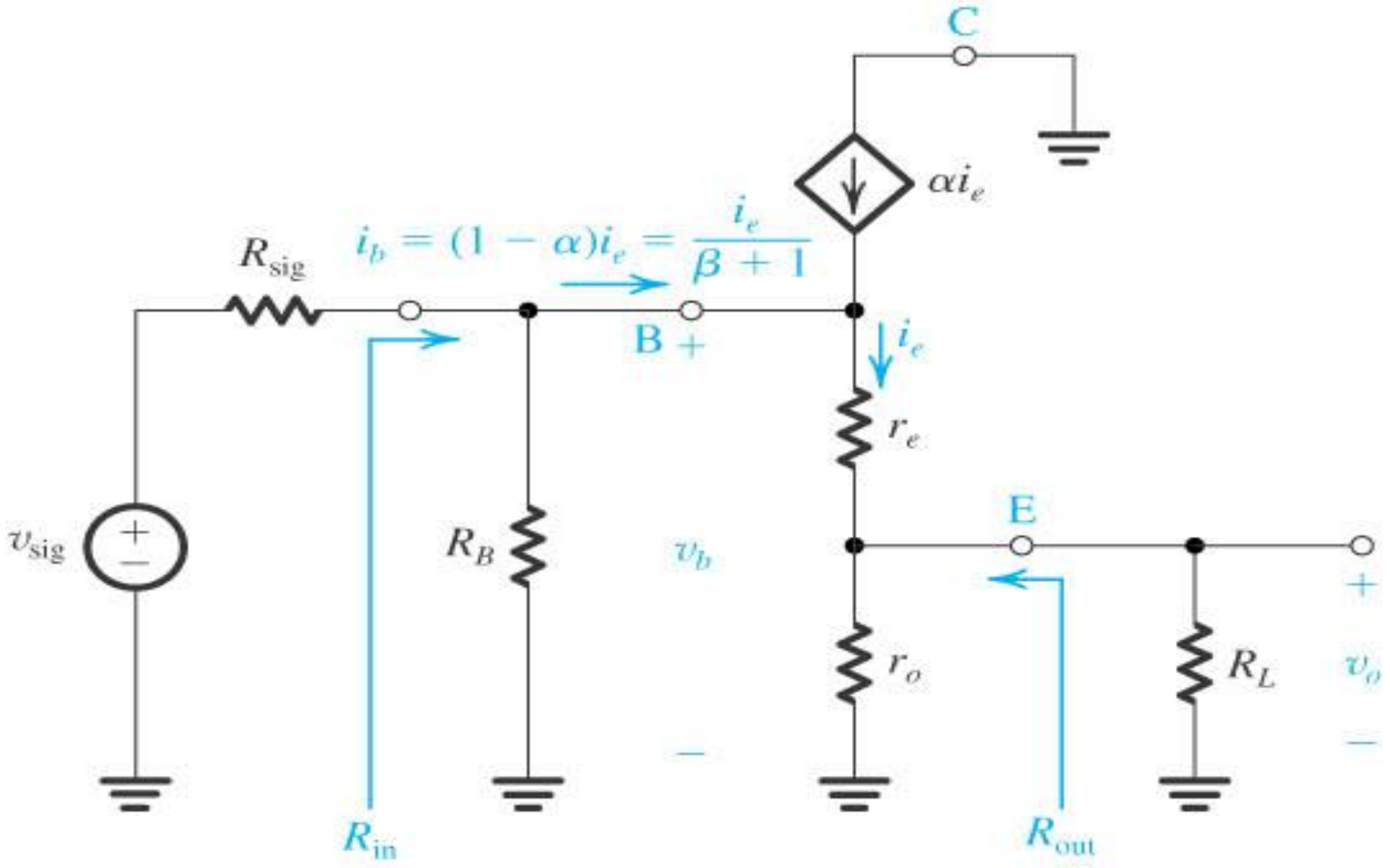


(a)

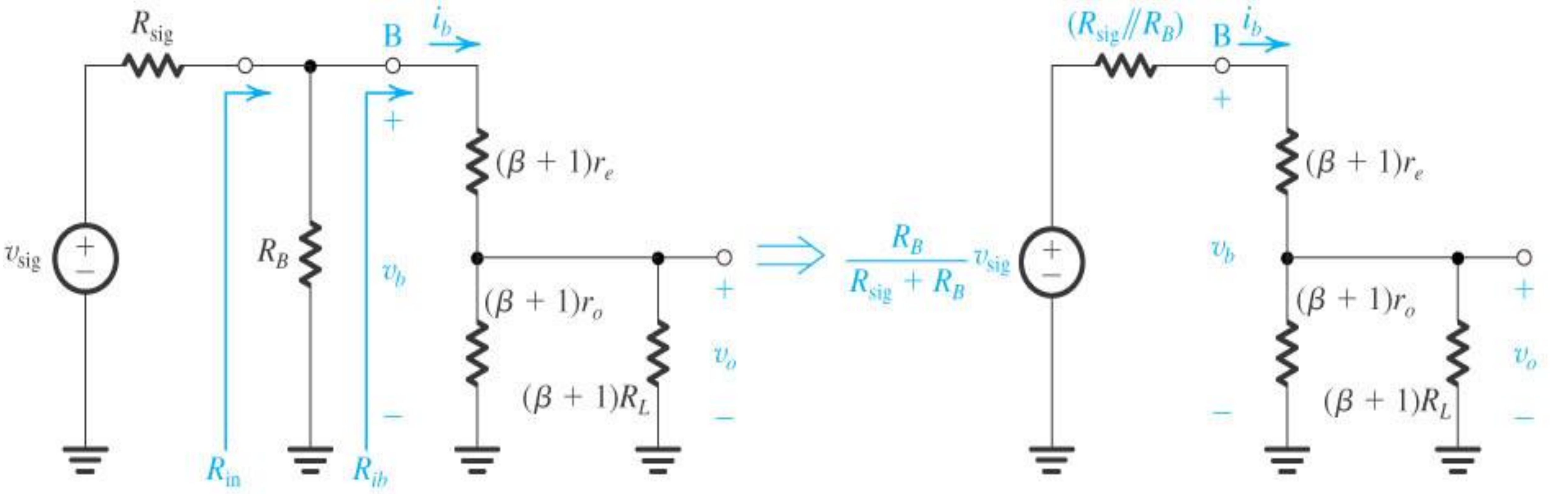
Small Signal Equivalent (CC config.)



(b)


C
αi_e
R_{sig}
$i_b = (1 - \alpha)i_e = \frac{i_e}{\beta + 1}$
B +
i_e
r_e
E
v_{sig}
R_B
v_b
+
r_o
R_L
v_o
−
−
R_{in}
R_{out}

(c)

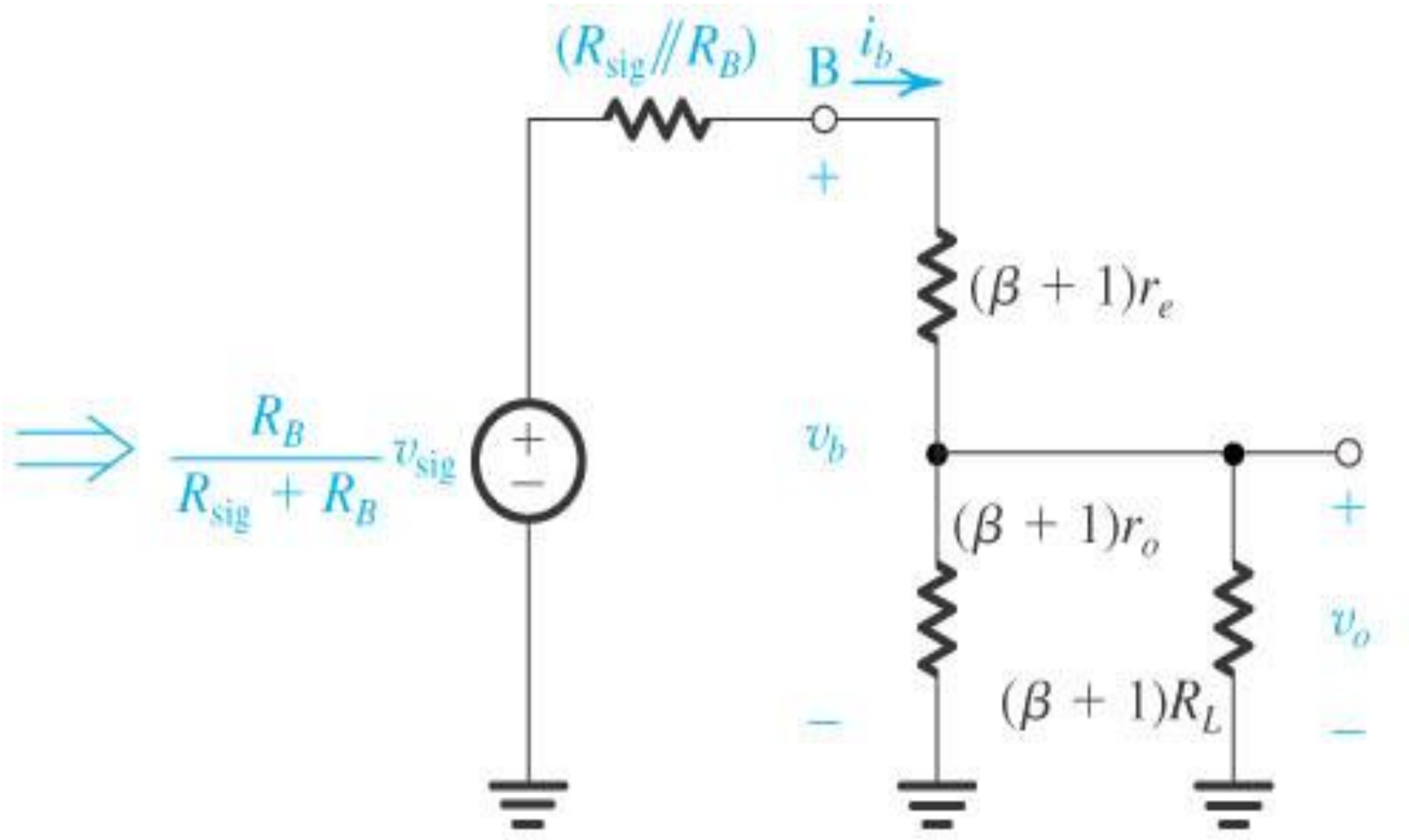


$$R_{\text{in}} = R_B /\!/ (\beta + 1)[r_e + (r_o /\!/ R_L)]$$

(a)

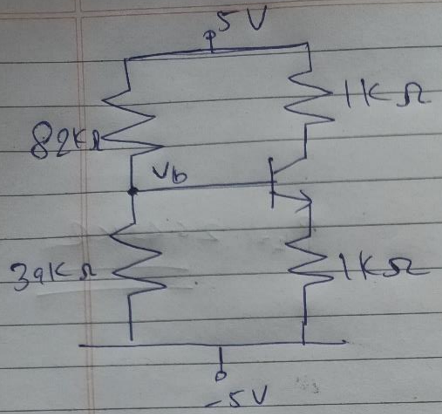
$$G_v = \frac{v_o}{v_{\text{sig}}} = \frac{R_B}{R_{\text{sig}} + R_B} \frac{(\beta + 1)(r_o /\!/ R_L)}{(R_{\text{sig}} /\!/ R_B) + (\beta + 1)[r_e + (r_o /\!/ R_L)]}$$

(b)



$$G_v = \frac{v_o}{v_{sig}} = \frac{R_B}{R_{sig} + R_B} \frac{(\beta + 1)(r_o /\!/ R_L)}{(R_{sig} /\!/ R_B) + (\beta + 1)[r_e + (r_o /\!/ R_L)]}$$

(b)

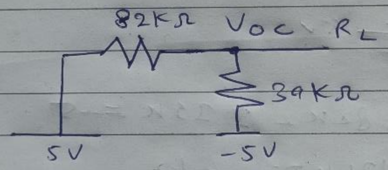


$$R_{th} = \frac{39 \times 82}{39 + 82}$$

$$R_{th} = 26.43\,k\Omega$$

$$+5V - 82k\,i_a - 39k\,i_a - (-5V) = 0$$

$$i_a = \frac{10}{121K}$$

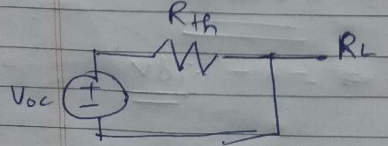


$$V_{oc} = 5 - 82K\,i_a$$

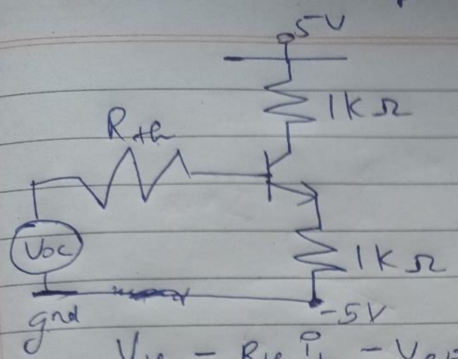
$$= 5 - \frac{82 \times 10\cancel{K}}{121\cancel{K}}$$

$$V_{oc} = -1.78V$$

$$V_{oc} = V_{th} = -1.78V$$



$$\beta = 100$$



$$i_c = i_e = \beta i_b$$
$$= 100 i_b$$

$$V_{oc} = V_{th} = -1.68V$$

$$R_{th} = 26.43k$$

$$i_e = i_c$$

$$V_{th} - R_{th}\,i_b - V_{BE} - 1K\,i_e = -5$$

$$-1.78 - 0.7 + 5 = 26.43K\,i_b + 100 i_b$$

$$i_b = \frac{2.52V}{126.43K\,\Omega}$$

$$i_b = 20\,\mu A$$

$$i_c = i_e = 2mA$$

$$5 - 1K\,i_c - V_{CE} - 1K\,i_c + 5 = 0$$

$$V_{CE} = 10 - 2K \times 2mA$$
$$= 6V$$

$$\underline{V_{CE} = 6V}$$

$$i_c = i_e = 2mA \quad i_b = 20\,\mu A$$

Thanks