Electronic Devices and Circuits

EME306

(Summer 2021-2022)

Lecture 12

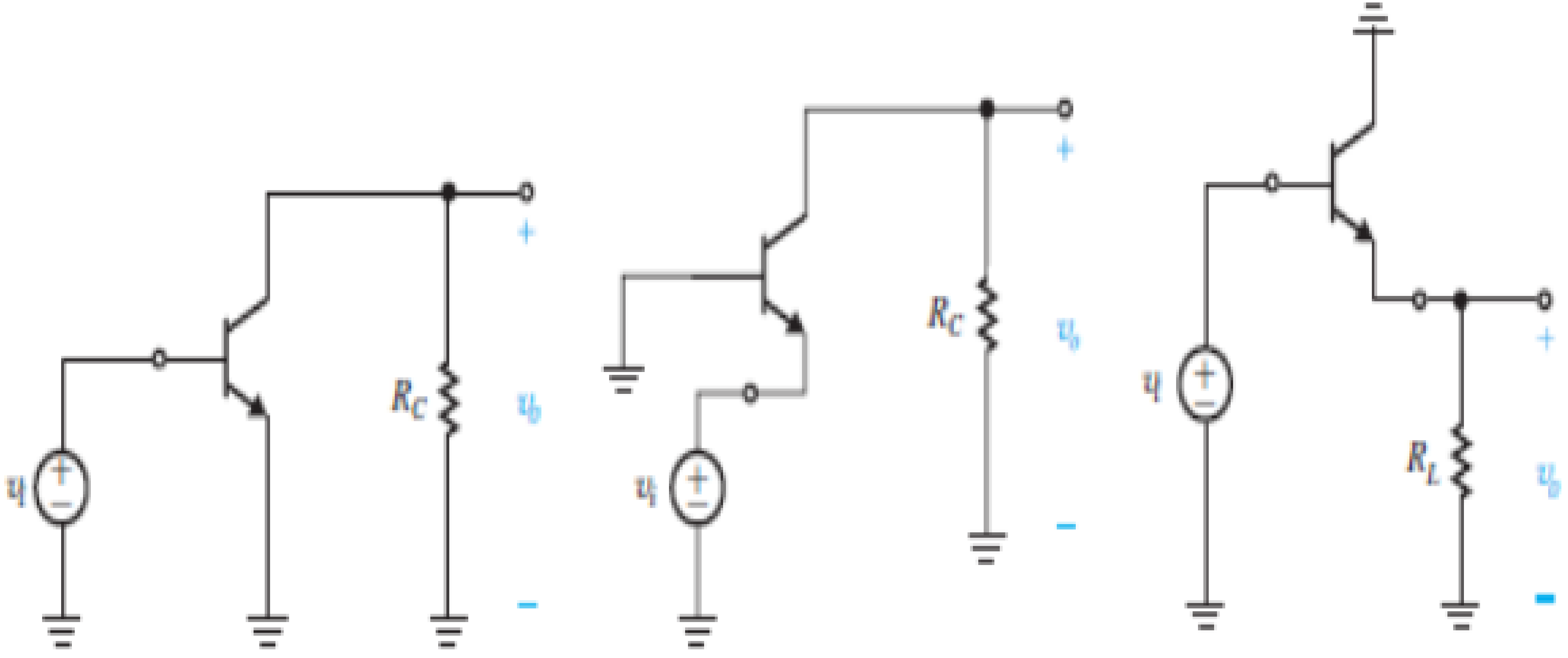
BJT as Amplifier Circuits

INSTRUCTOR

Dr / Ayman Soliman

Contents

The Three Basic Configurations



(d) Common-Emitter (CE)

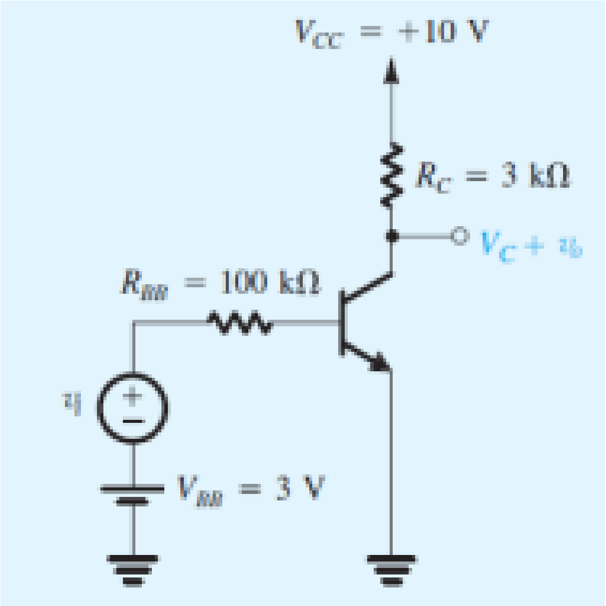
(e) Common-Base (CB)

(f) Common-Collector (CC) or Emitter Follower

1- Common Emitter

Example

For the transistor amplifier shown in Figure, determine its voltage gain v_o/v_i. Assume β = 100 and neglect the Early effect.



Dc analysis

- All capacitors are Open circuits
- All ac voltage are short circuit
- All ac currents are open circuits

Solve as usual

Assume transistor is in active region

Take loop shown

$$V_{BB} = I_B * R_{BB} + V_{BE}$$

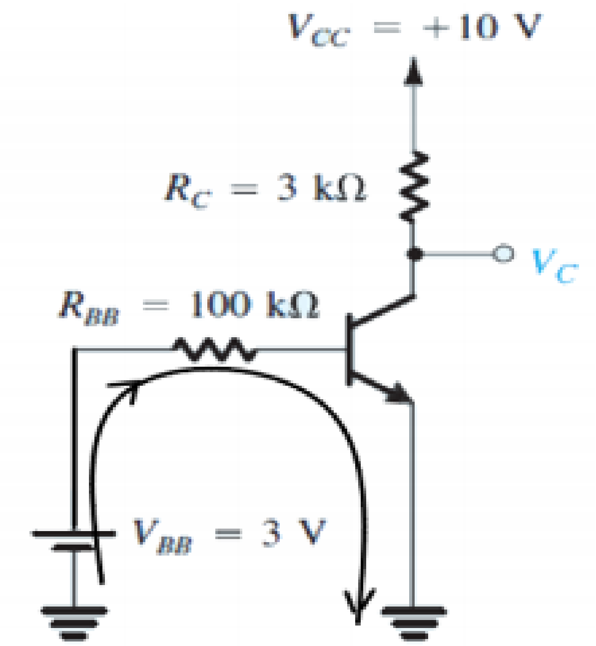
$$3.0 = I_B * 100 + 0.7$$

$$I_B = 0.023mA$$

$$I_c = \beta I_B = 2.3mA$$

$$V_C = 10 - 3 * I_c = 3.1V$$

$$V_E = 0, \quad V_B = 0.7v$$



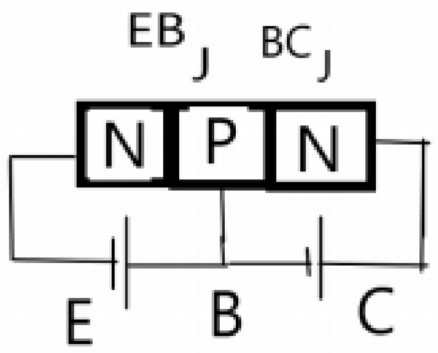
Check

V_E= 0v , V_B=0.7v, V_c = 3.1v

Since $V_B > V_E$ Then EB_J is Forward

Sine $V_C > V_B$ Then BC_J is reverse

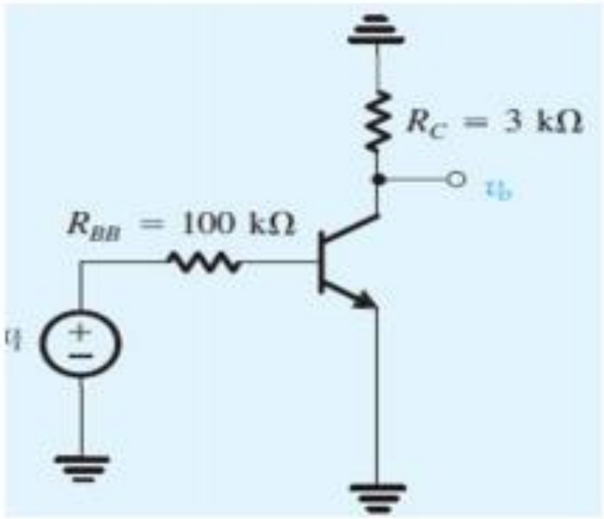
Then Transistor operates in Active as assumed



$$r_\pi = V_T / I_B = 0.025 / 0.023 = 1.0869 K\Omega$$

ac analysis

- All capacitors are short circuits
- All Dc voltage are short circuit
- All Dc currents are open circuits
- Replace transistor by equivalent model

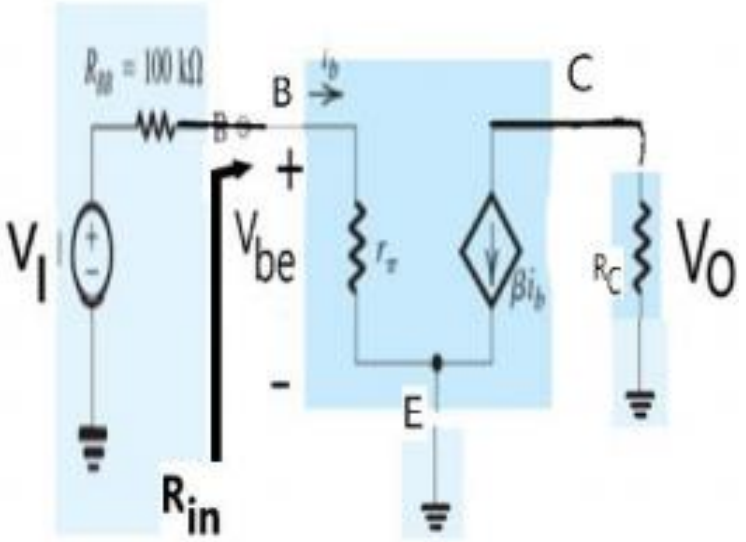


$$v_i = i_b(R_{BB} + r_\pi) \qquad (1)$$

$$v_{be} = ib(r_\pi)$$

$$R_{in} = \frac{v_{be}}{i_b} = r_\pi = 1.087\,K\Omega \qquad (2)$$

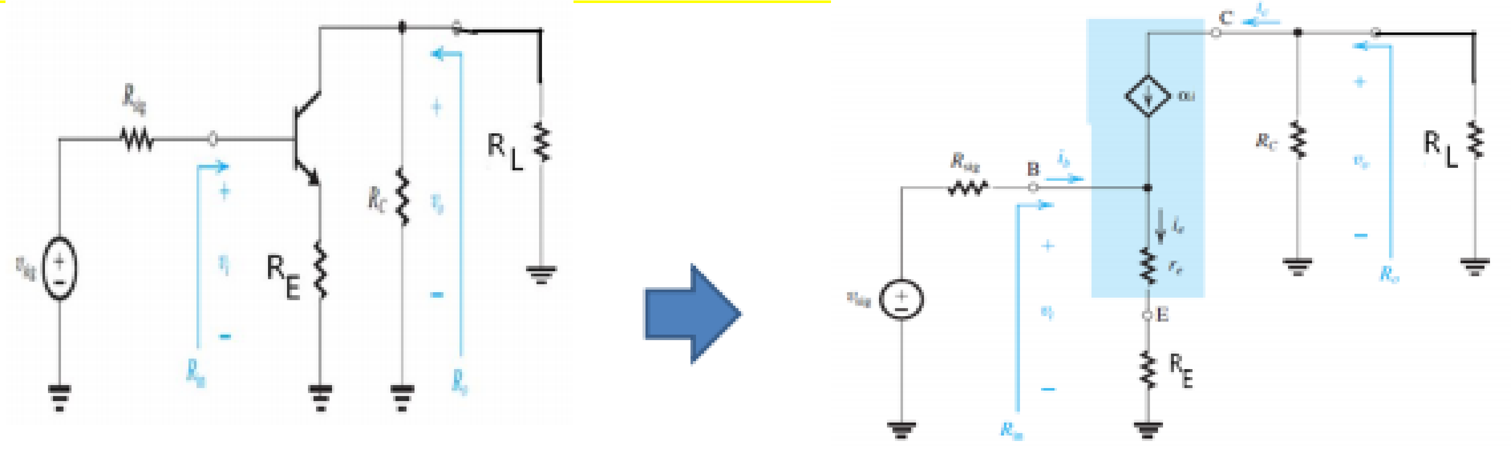
$$v_o = -\beta i_b R_c \qquad (3)$$



From Eqs. (1) and (3)

$$\frac{v_0}{v_i} = \frac{-\beta R_c}{R_{BB} + r_\pi} = -2.96\,v/v \qquad (4)$$

Common-Emitter Amplifier with Emitter Resistance



$$v_i = i_e(r_e + R_E) = (1+\beta)i_b(r_e + R_E) \qquad (1)$$

$$i_i = i_b$$

$$R_{in} = v_i / i_i = (1+\beta)(r_e + R_E)$$

$$v_{oo} = -\alpha i_e R_c \qquad (2)$$

From Eqs (1) & (2), then

$$A_{vo} = \frac{v_{oo}}{v_i} = -\alpha \frac{R_c}{r_e + R_E}$$

$$A_{vo} = \frac{v_{oo}}{v_i} = -\alpha \frac{R_c}{r_e + R_E} = -\alpha \frac{total \quad resistance \quad in \quad collector}{total \quad resistance \quad in \quad emitter}$$

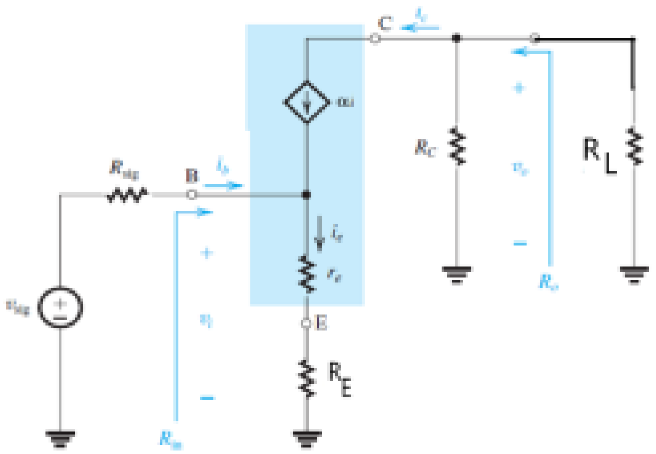
$$A_{vo} = \frac{v_{oo}}{v_i} = -\alpha \frac{R_c}{r_e + R_E}$$

$$v_i = i_e(r_e + R_E) \qquad (1)$$

$$v_o = -\alpha i_e (R_c // R_L) \qquad (3)$$

From Eqs (1) & (3), then

$$A_v = \frac{v_o}{v_i} = -\alpha \frac{R_c // R_L}{r_e + R_E}$$



$$G_{vo} = \frac{v_{oo}}{v_i} \frac{v_i}{v_{sig}} = -\frac{\alpha R_c}{r_e + R_E} \cdot \frac{R_{in}}{R_{in} + R_{sig}}$$

$$G_v = \frac{v_o}{v_i} \frac{v_i}{v_{sig}} = -\frac{\alpha R_c // R_L}{r_e + R_E} \cdot \frac{R_{in}}{R_{in} + R_{sig}}$$

$$G_v = -\beta \frac{R_c // R_L}{R_{sig} + (1+\beta)(r_e + R_E)}$$

$$R_o = R_c$$


Thank you