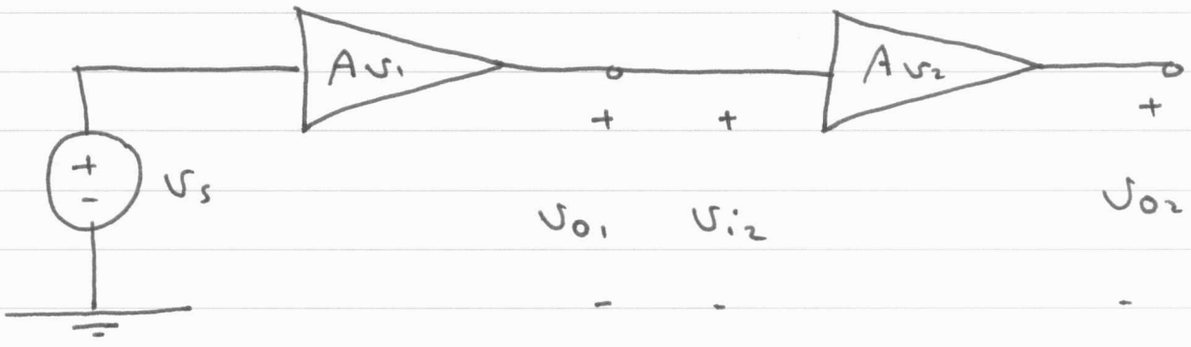
Multistage Amplifiers

1. Additional Amplification can be required.
2. Improving the performance of the amplifier (high input impedance, high gain, small output impedance).
3. Increasing the Bandwidth.



$$v_{o_2} = A_{v_2} v_{i_2}$$

$$v_{i_2} = v_{o_1} \qquad \text{(in cascade)}$$

$$v_{o_1} = A_{v_1} v_s$$

$$\therefore \frac{v_{o_2}}{v_s} = A_{v_1} \cdot A_{v_2}$$

* When the output of one amplifier stage is connected to the input of another, the amplifier stages are said to be in Cascade.

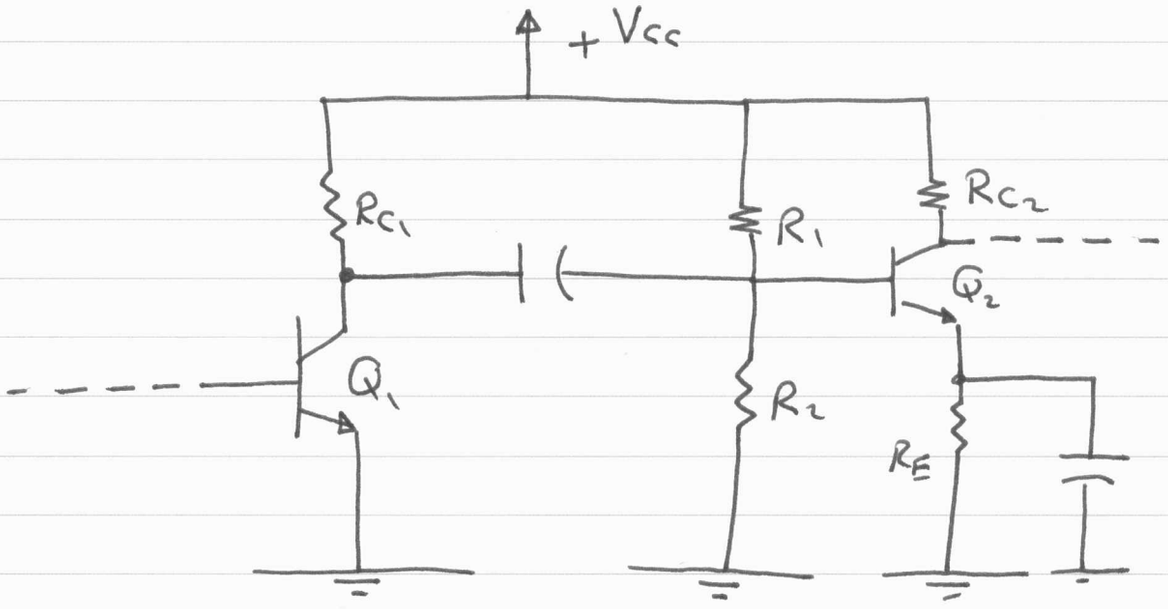
* $A_{VT} = A_{V_1} \cdot A_{V_2} \cdot A_{V_3} \cdot \ldots A_{Vn}$

A_{V_1}, A_{V_2}, and A_{Vn} are the in-circuit gains.

Methods of Coupling

1) Capacitor Coupling
2) Direct Coupling
3) Transformer Coupling

1) Capacitor Coupled Multistage Amplifier

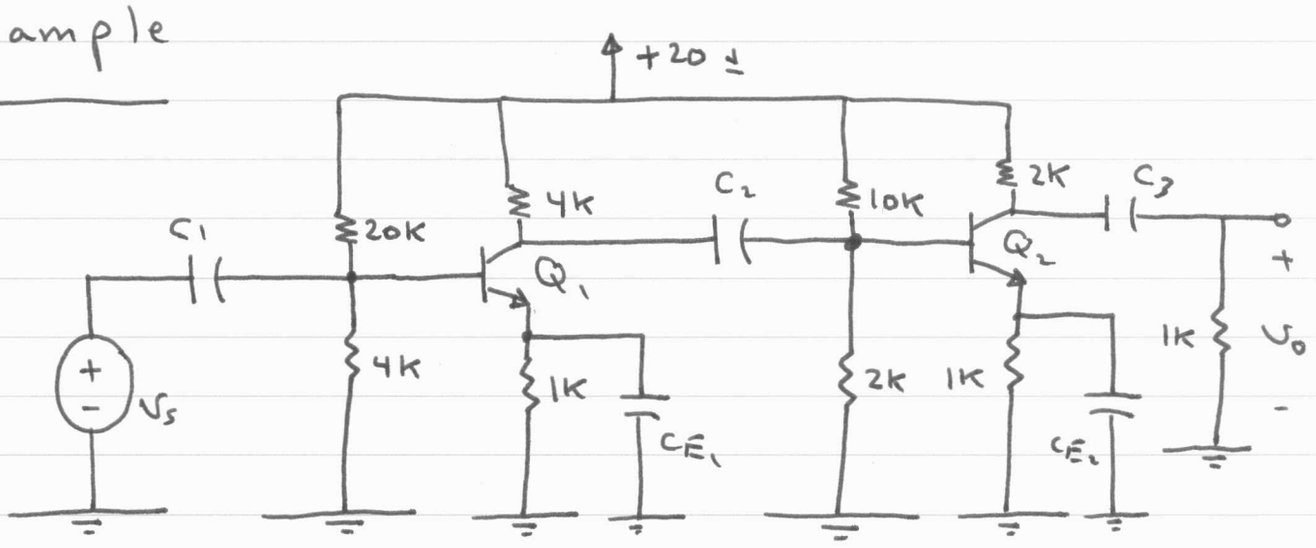


- The coupling capacitor blocks the flow of Dc current while it permits the flow of ac signal between stager.
- It makes it possible to have a dc biar voltage at the output of one stage that is different from the dc biar voltage at the input to the next stage (stage isolation).

Disadvantages

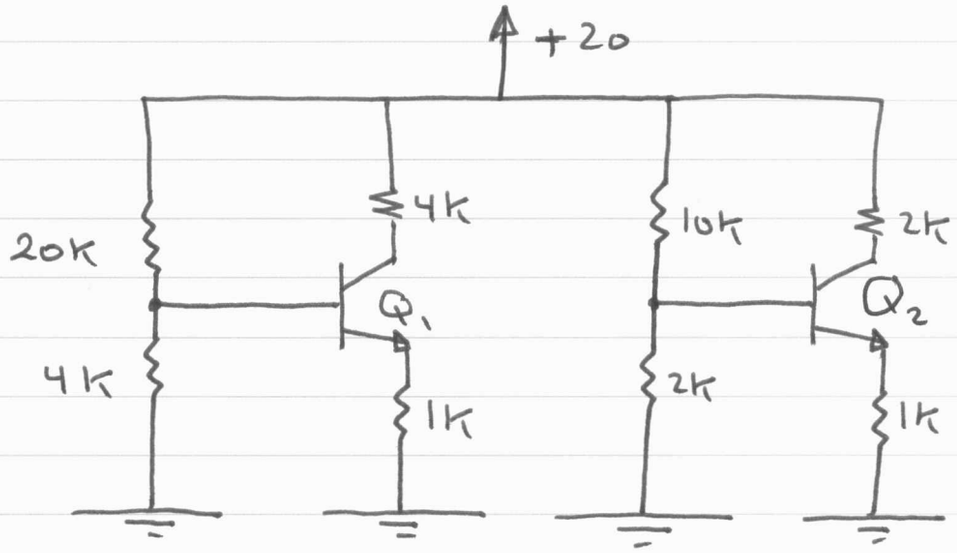
- It effects the low-frequency response of the amplifier
- Is not used in integrated circuits, because it is difficult and uneconomical to fabricate capacitors on a chip.

Example



$\beta_1 = \beta_2 = 50$

Dc Analysis



$R_{TH_1} = 4K \| 20K = 3.33K$

$V_{TH_1} = \frac{4K}{4K+20K}(20) = 3.33V$

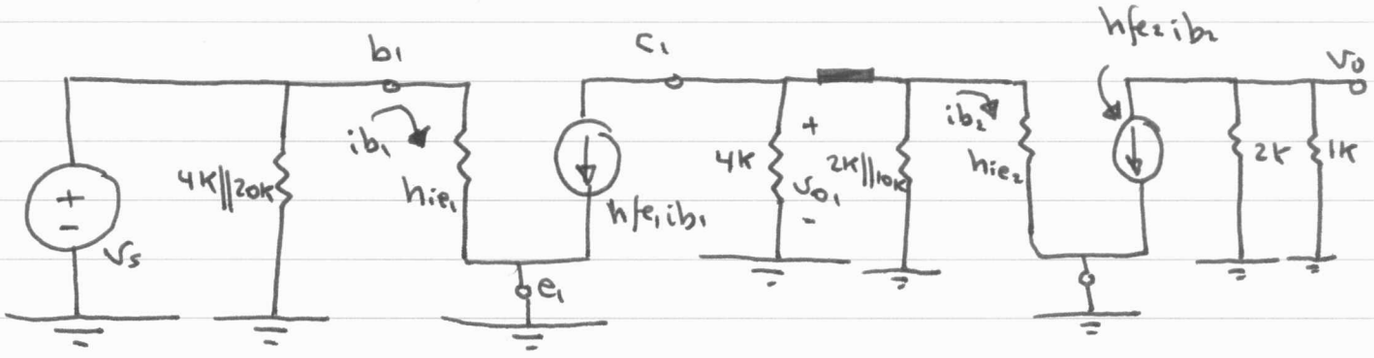
$I_{E_1} = 2.47mA \longrightarrow h_{ie_1} \cong 0.51K$

$R_{TH_2} = 2K \| 10K = 1.67K$

$V_{TH_2} = \frac{2K}{2K+10K}(20) = 3.33V$

$I_{E_2} = 2.55mA \longrightarrow h_{ie_2} \cong 0.51K$

Ac small signal equivalent circuit



$$A_{VT} = A_{V1} \cdot A_{V2}$$

$$- A_{V1} = \frac{V_{o1}}{V_s}$$

$$V_{o1} = - h_{fe1} i_{b1} \left(4K \| 2K \| 10K \| h_{ie2} \right)$$

$$i_{b1} = \frac{V_s}{h_{ie1}}$$

$$\therefore A_{V1} = - 35.14$$

$$- A_{V2} = \frac{V_{o2}}{V_{i2}} = \frac{V_{o2}}{V_{o1}} = \frac{V_o}{V_{o1}}$$

$$V_{o1} = - h_{fe2} i_{b2} (2K \| 1K)$$

$$i_{b2} = \frac{V_{o1}}{h_{ie2}}$$

$$\therefore A_{V2} = - 66.66$$

$$\therefore A_{V2} = A_{V1} \cdot A_{V2}$$

$$A_{V2} = 2342$$