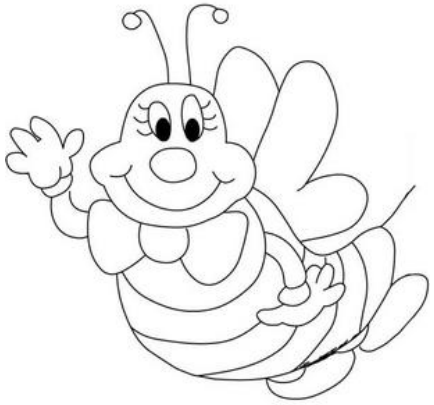
Multistage Amplifiers

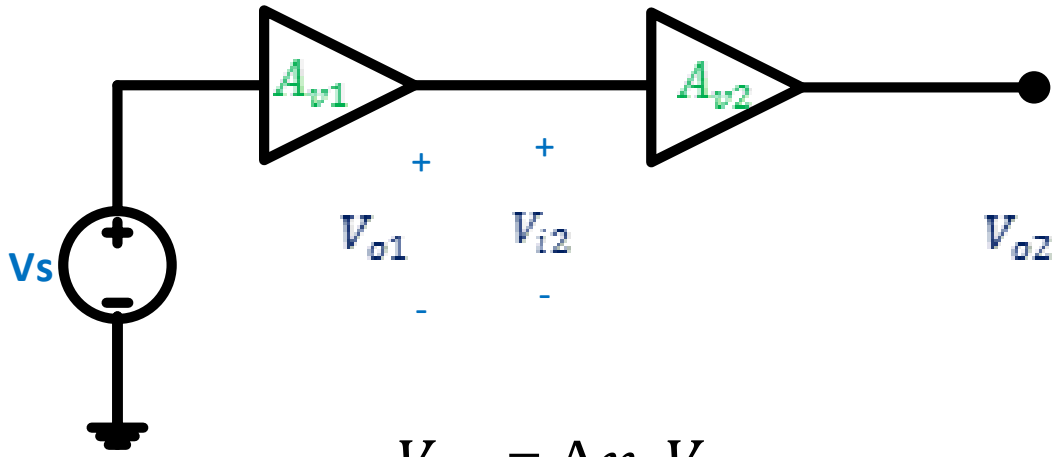


1) Additional Amplification can be required .

2) Improving the performance of the amplifier (high input impedance ,high gain , small output impedance) .

3) Increasing the Bandwidth .

Multistage Amplifiers



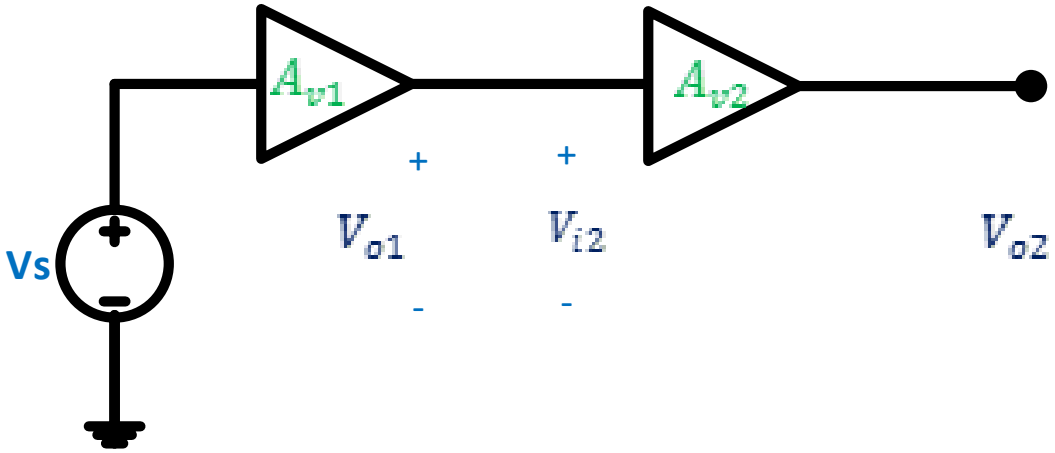
$$V_{O2} = \mathrm{A}v_2 V_{i2}$$

$$V_{i2} = V_{O1}$$

$$V_{O1} = \mathrm{A}v_1 V_S$$

$$\frac{V_{O2}}{V_S} = \mathrm{A}v_1 . \mathrm{A}v_2$$

Multistage Amplifiers



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

- $Av_T = Av_1 . Av_2 . Av_3 \ldots\ldots Av_n$
  Av_1 , Av_2, and Av_n are the in – circuit gains .

Multistage Amplifiers

Methods of Coupling:

- **Capacitor Coupling.**
- **Direct Coupling.**
- **Transformer Coupling.**

Capacitor Coupled Multistage Amplifier

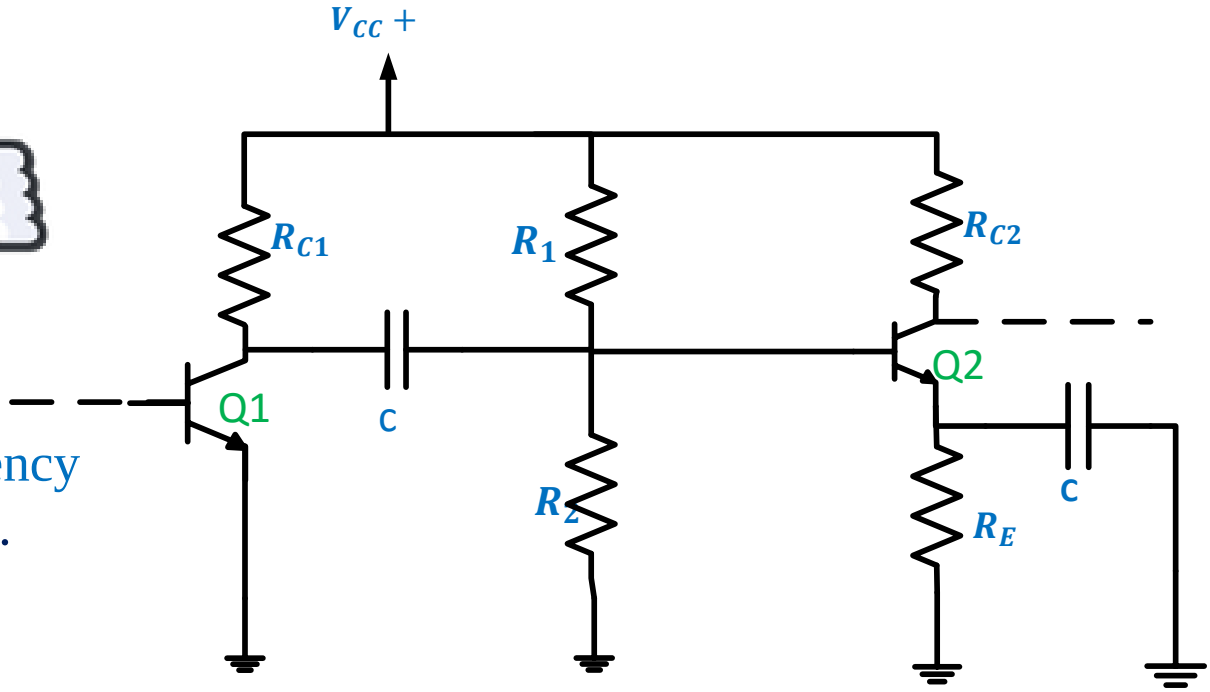
Advantages:

- the coupling capacitor **blocks** the flow of DC current while it **permits** the flow of Ac signal between stages .

- It makes it possible to have a dc bias voltage at the output of one stage that is different from the dc bias voltage at the input to the next stage (stage isolation) .

Capacitor Coupled Multistage Amplifier

Disadvantages:

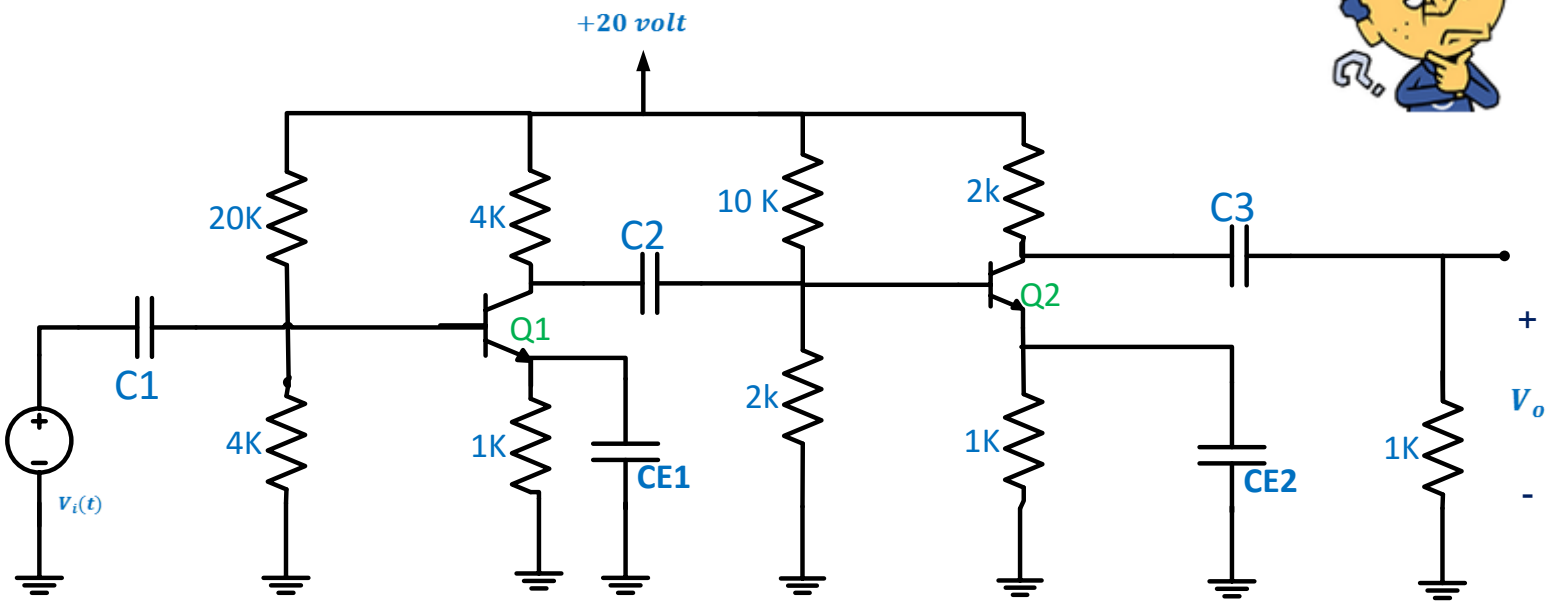


- It effects the low – frequency response of the amplifier .

- It not used in integrated circuit , **because** it is difficult and uneconomical to fabricate capacitors on a chip .

Capacitor Coupled Multistage Amplifier

Example: **find the gain of the multistage amplifier**

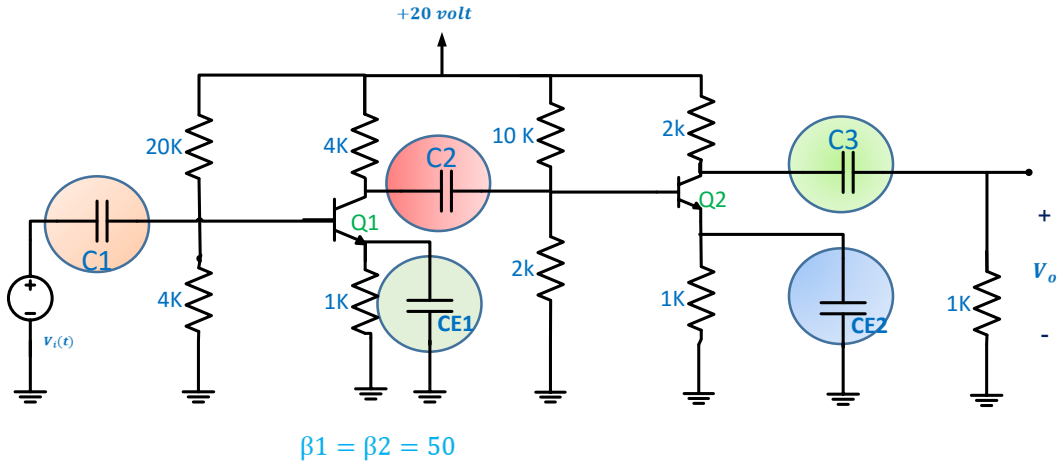


$\beta 1 = \beta 2 = 50$

Capacitor Coupled Multistage Amplifier

Solution:

DC Analysis:

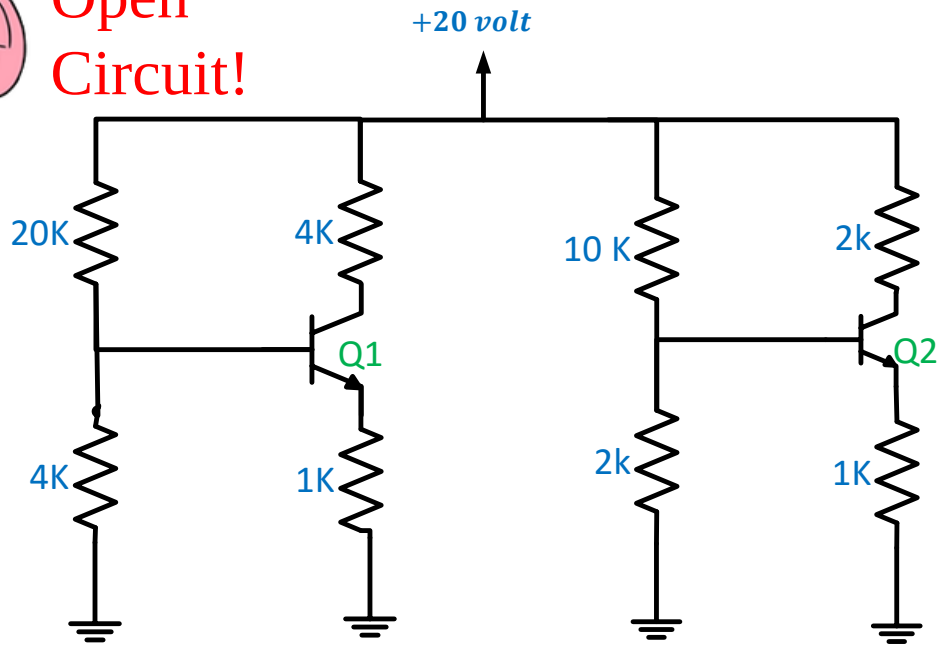


$\beta 1 = \beta 2 = 50$

R_{TH1}= 4K \\ 20K = 3.33K

$V_{TH1} = \frac{4K}{4K+20K}(20) = 3.33v$

Open Circuit!



I_{E1}=2.47 mA $\quad \therefore h_{ie1} = 0.51K$

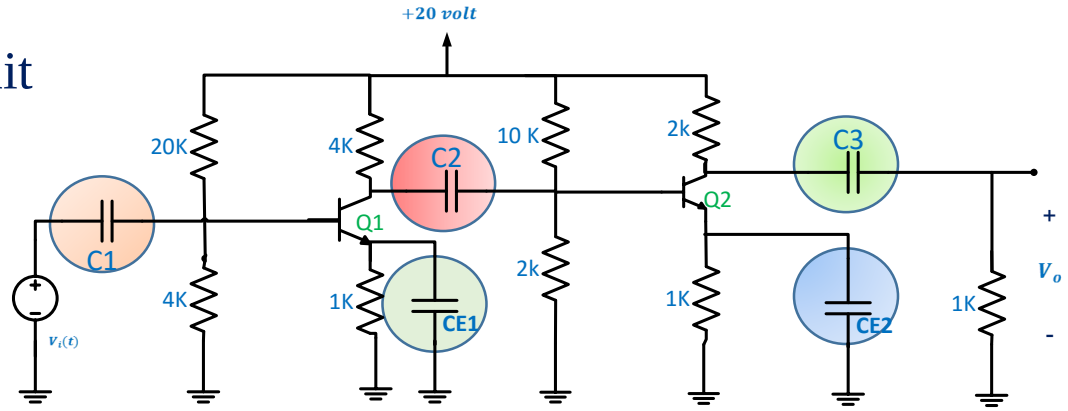
R_{TH2}= 2K \\ 10K = 1.67 K

$V_{TH2} = \frac{2K}{2K+10K}(20) = 3.33v$

I_{E2}=2.55 mA $\quad \therefore h_{ie2} \approx 0.51K$

Capacitor Coupled Multistage Amplifier

Ac small signal equivalent circuit

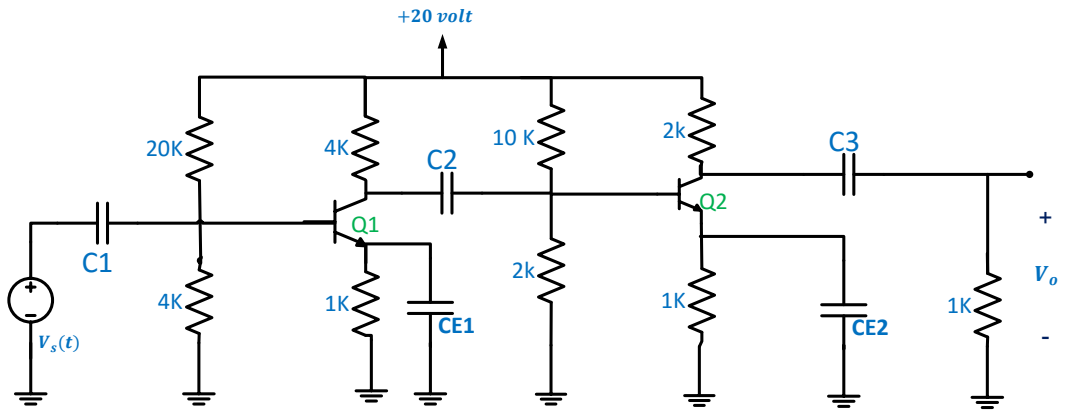


$\beta 1 = \beta 2 = 50$

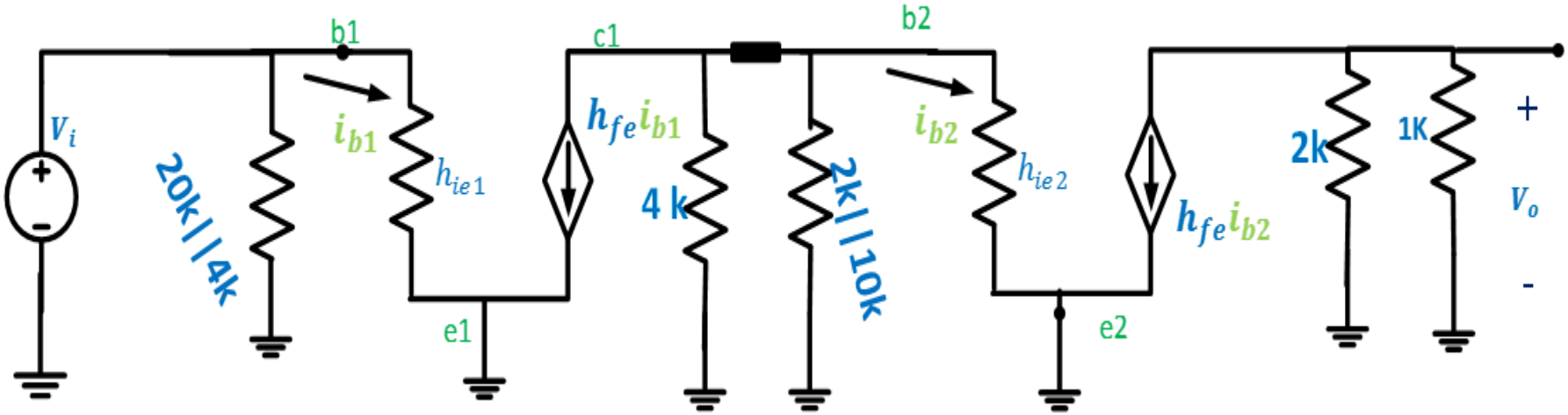
Short Circuit

Capacitor Coupled Multistage Amplifier

Ac small signal equivalent circuit

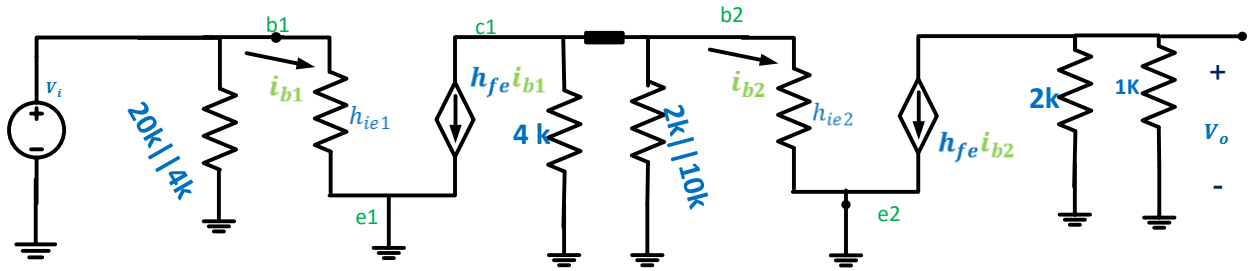


$\beta 1 = \beta 2 = 50$



Capacitor Coupled Multistage Amplifier

$$Av_T = Av_1 . Av_2$$



- $Av_1 = \frac{V_{O1}}{V_i}$

$$V_{O1} = -h_{fe1} ib_1 (4k||2k||10k||h_{ie2})$$

$$ib_1 = \frac{V_i}{h_{ie1}}$$

- $Av_1 = -34.14$

$$ib_2 = \frac{V_{i2}}{h_{ie2}}$$

- $Av_2 = -66.66$

$$Av_T = Av_1 . Av_2$$

- $Av_2 = \frac{V_{O2}}{V_{i2}} = \frac{V_O}{V_{i2}}$

$$V_{O2} = -h_{fe2} ib_2 (1k||2k)$$

❖ $Av_T = 2342$