Negative Feedback

Negative Feedback

Advantages

1-Stabilizes the gain of the amplifier against parameters changes in the active devices due to temperature .
2- Modifies the input and output impedance in any desired fashion.
3- Increases the Bandwidth .

Disadvantages

1. **Decreases the gain .**
2. **Oscillation .**

Negative Feedback

General Feedback equation

$S_O = AS_\epsilon$

$S_\epsilon = S_{i-}S_{fb}$

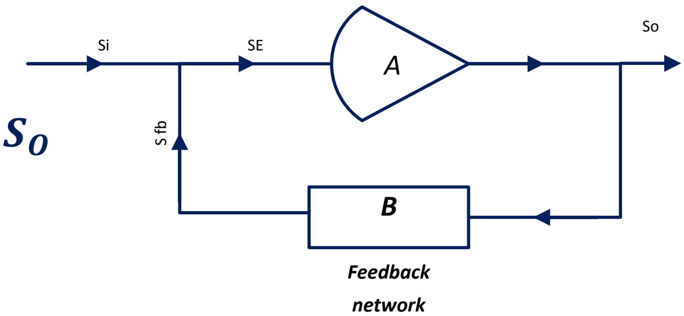
$A_f = \frac{S_O}{S_i} = \frac{A}{1+A\beta}$

A $\beta \equiv$ Loop gain

If A $\beta \gg 1$

$\therefore A_f = \frac{1}{\beta}$

$S_{fb} = \beta\ S_O$



Negative Feedback

General Feedback equation

$S_\epsilon = S_{i-}S_{fb}$

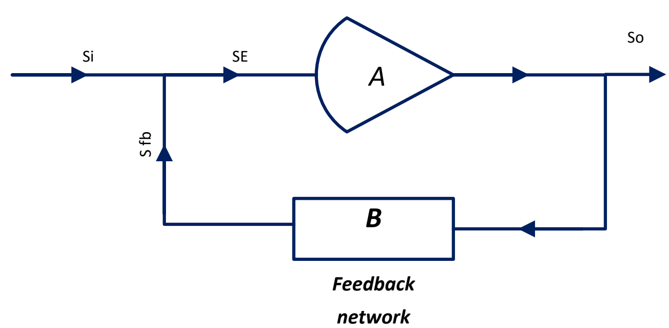
$S_\epsilon = S_{i-}\beta S_O$

$S_\epsilon = S_{i\ -}\ \beta\frac{A}{1+AB}S_i$

$S_\epsilon = S_i(1- \frac{A\beta}{1+A\beta})$

If A $\beta \gg 1$

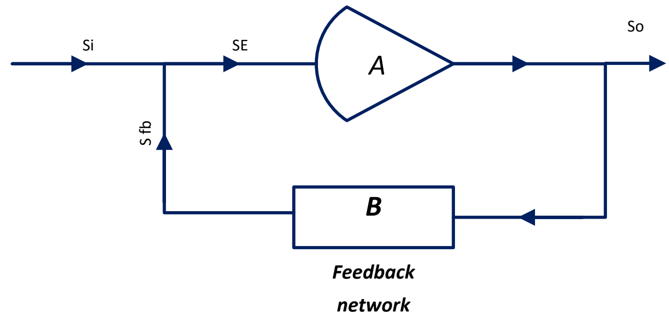
$S_\epsilon \approx S_i(1- \frac{A\beta}{A\beta}) \approx 0$



Negative Feedback

Gain stabilization

$$let\ A = 10,000$$
$$\beta = 0.01$$
$$\therefore A\beta = 100$$
$$Af = \frac{A}{1 + A\beta} = 99$$



$$let\ A = 9000$$
$$\beta = 0.01$$
$$\therefore A\beta = 90$$
$$Af = \frac{A}{1 + A\beta} = 98.9$$

Change in A → change in Af

10% → 0.1%

Negative Feedback

Increasing the Bandwidth.

At high frequency

$$A(jw) = \frac{A_m}{1 + \frac{jw}{w2}}$$

$$\therefore wH = w2$$

With Negative Feedback

$$Af(jw) = \frac{A(jw)}{1 + A(jw)\beta}$$

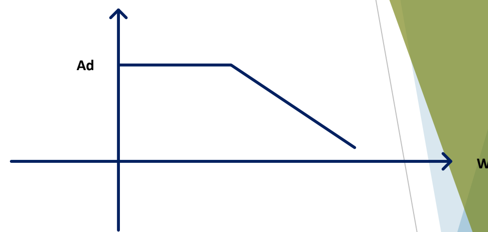
$$Af(jw) = \frac{A_m}{1 + A_m\beta} \cdot \frac{1}{1 + \frac{jw}{w2(1 + A_m\beta)}}$$

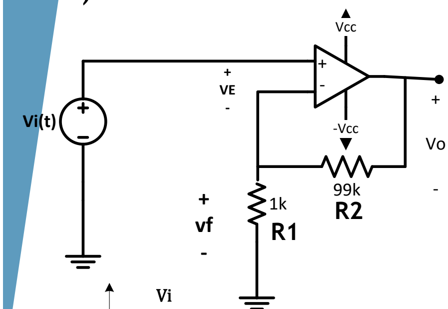
$$\therefore wH = w2(1 + A_m\beta)$$

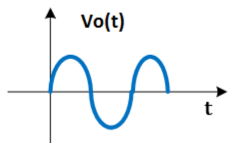
Oscillators

The Oscillation Problem

1)At mid band

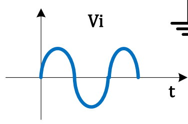




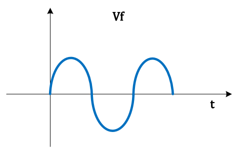


$V_{\epsilon} = v_i - v_f < v_i$

Negative Feedback



$$v_f = \frac{R_1}{R_1+R_2} Vo$$

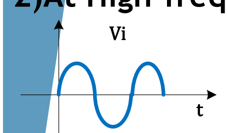


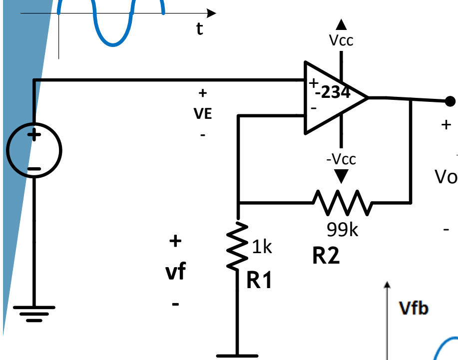
Vf Opposes vi

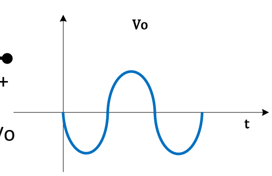
Oscillators

The Oscillation Problem

2)At High-frequency (phase = 180) at w0



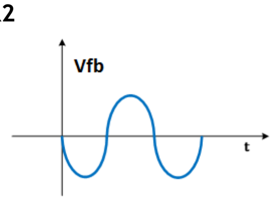




$V_{\epsilon} = v_i - v_f > v_i$

Positive Feedback

$$v_f = \frac{R_1}{R_1+R_2} V_O$$



v_{fb} **adds to** v_i

Oscillators

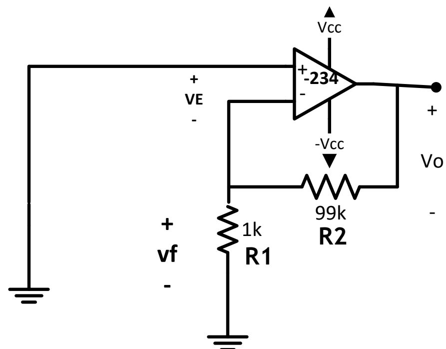
The Oscillation Problem

Now let $v_i = 0$

$\therefore V_{\epsilon} = -v_{fb}$

$V_o = AV_\epsilon$

$v_{fb} = \frac{R_1}{R_1+R_2} V_O = \frac{1}{100} V_O$

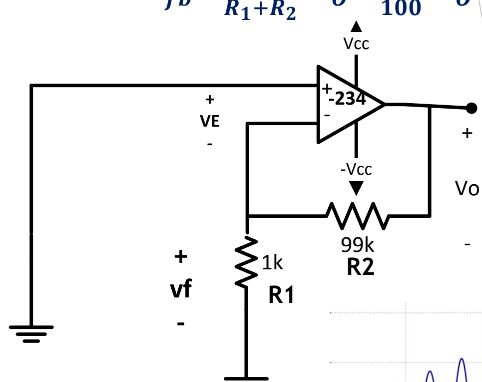


Oscillators

The Oscillation Problem

$V_o = AV_\epsilon$

$v_{fb} = \frac{R_1}{R_1+R_2} V_O = \frac{1}{100} V_O$



1. Let $V_{\epsilon 1} = 1mV\ peak$

   $V_{o1} = -234mV\ peak$

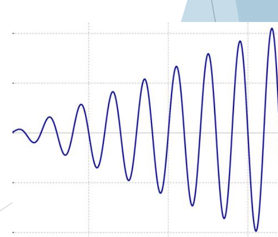
   $V_{fb1} = -2.34mV\ peak$

2. $V_{\epsilon 2} = -v_{fb1} = 2.34mV\ peak$

   $V_{o2} =$-548 mV peak

   $V_{fb2} =$-5.48 mV peak

3. $V_{\epsilon 3} =$ - $V_{fb2} =$ 5.48mV peak

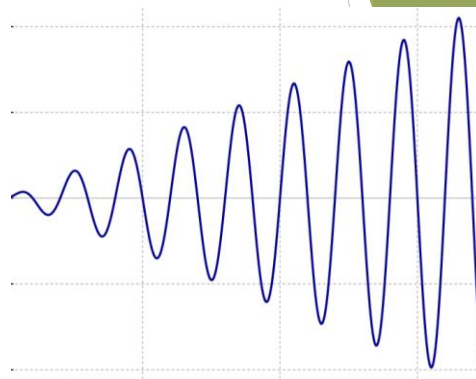


Oscillators

The Oscillation Problem

Building up voltage

$$|V_{fb1}| > |V_{\epsilon 1}|$$
$$|\beta V_{o1}| > |V_{\epsilon 1}|$$
$$|A\beta V_{\epsilon}| > |V_{\epsilon 1}|$$
$$\therefore |A\beta| > 1$$



Oscillators

The Oscillation Problem

1. **Let A = -100**

$V_{\epsilon 1} =$ **100 mV peak**

$\therefore$ $V_{o1} =$ **-10V peak**

V_{fb1} **= -100 mV peak**

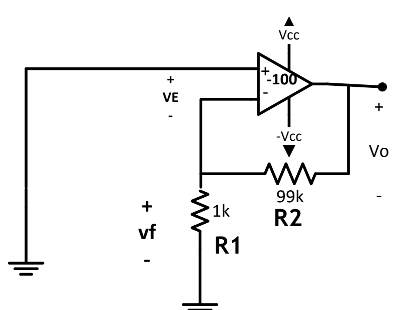
2. $V_{\epsilon 2} = -V_{fb}$ **= 100 mV peak**

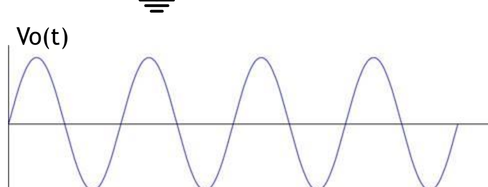
$V_{o2} = -$**10V peak**

V_{fb2} **= -100 mV peak**

The out put signal is sustained

$$|V_{fb1}| = |V_{\epsilon 1}|$$
$$|A\beta| = 1$$





Oscillators

The Oscillation Problem

Now let change $R_{2\,=}$ 299K

$\therefore \beta = \frac{1}{300}$

A = -234

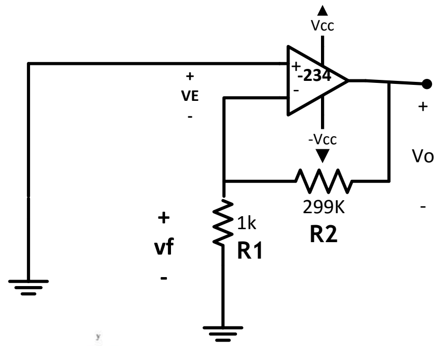
1. $V_{\epsilon 1\,=}$ 1 mV peak

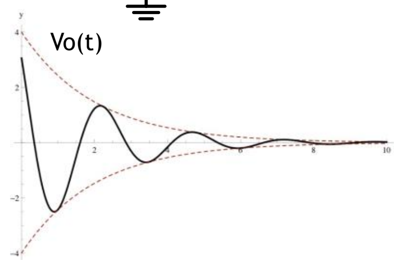
   $V_{o1\,=}$ -234mV peak

   v_{fb1} = -0.78 mV peak

2. $V_{\epsilon 2\,=} - v_{fb1} = 2.34mV\ peak$

$\therefore$ V_ϵ , V_o ,v_{fb} are decreasing down $|A\beta| < 1$





Oscillators

The Oscillation Problem

White noise

-All active and passive devices will generate small levels (typically, nano volts or less) of white noise.

-White noise are random generation of electrical signal that encompass the frequency spectrum from dc (0Hz) to extremely high (many gaga hertz frequencies).

-Thermal energy will produce a random motion in free electrons . this random electrons motion serves to produce a random current . If this random current exists in a resistor , a random (noise) voltage will be developed a cross the resistor.