Negative Feedback

Negative Feedback

Advantages

1-Stabilizes the gain of the amplifier against parameters changes in the active devices due to temperature .

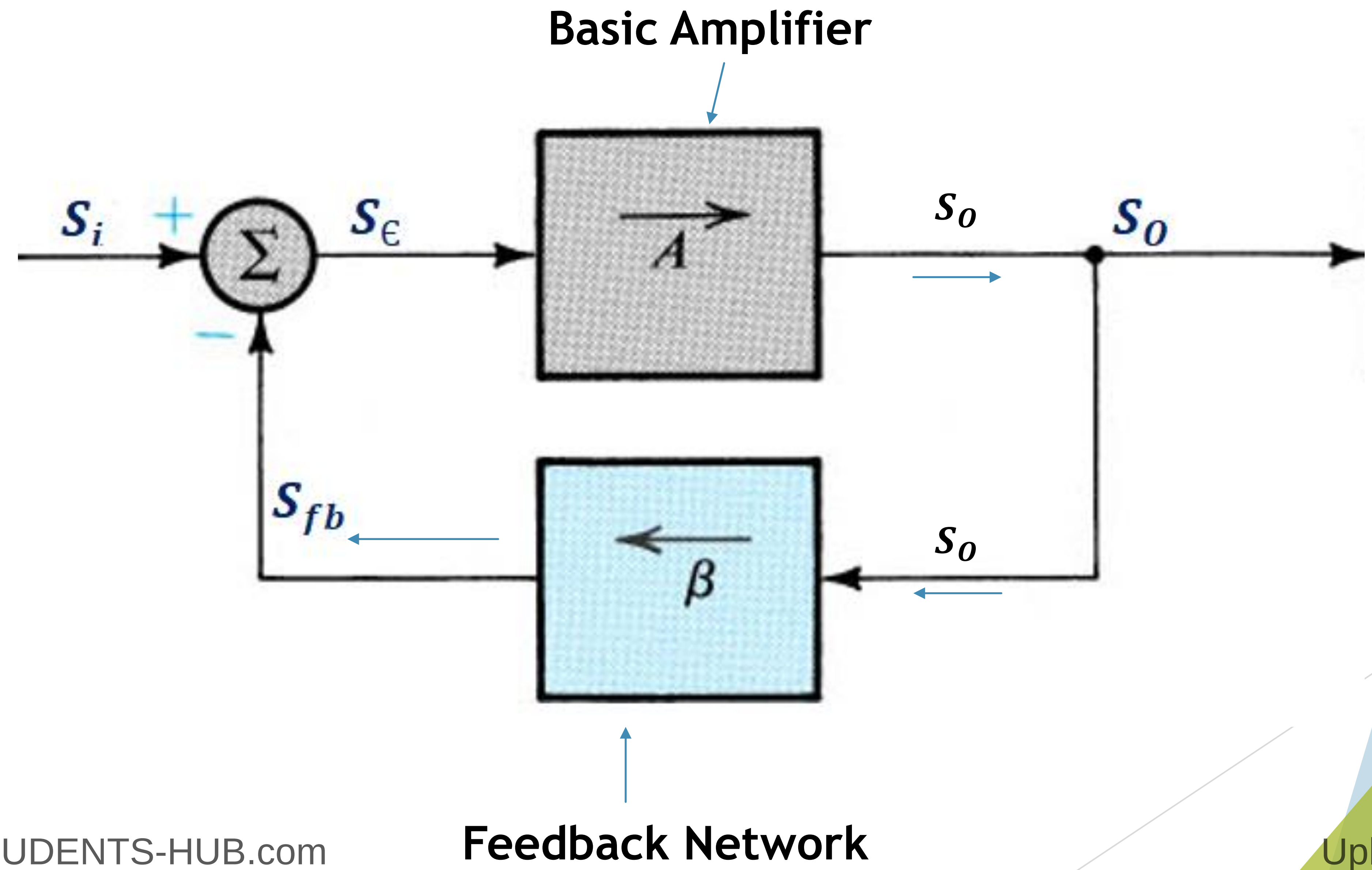
2- Modifies the input and output impedance in any desired fashion.

3- Increases the Bandwidth .

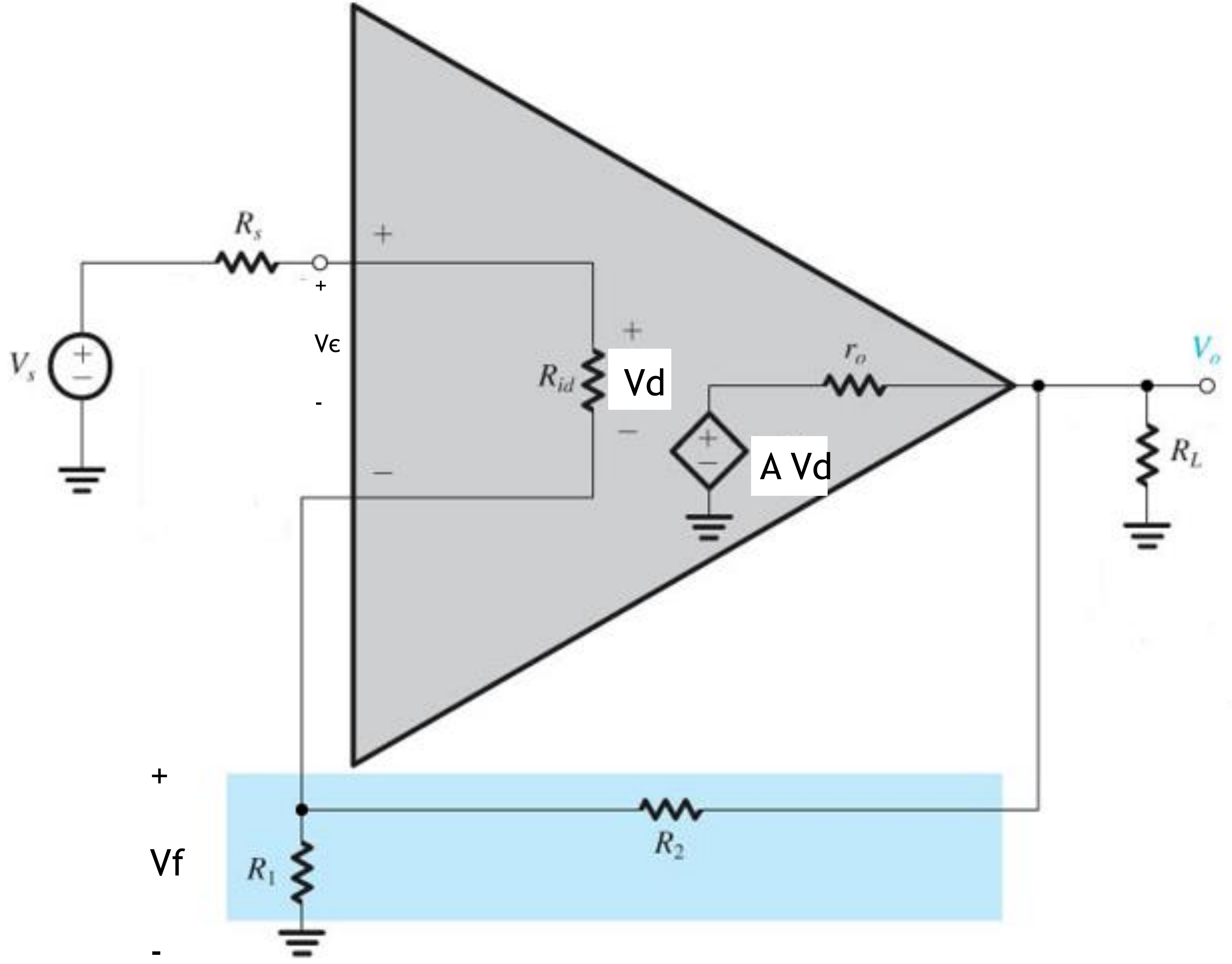
Disadvantages

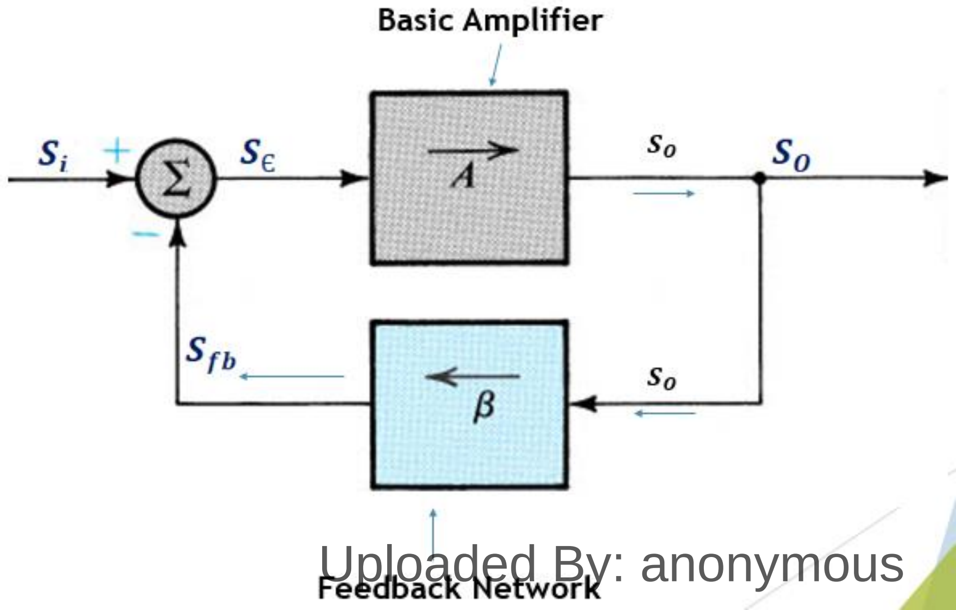
1. **Decreases the gain .**
2. **Oscillation .**

The General Feedback Structure



Example of Feedback Amplifier





Negative Feedback

General Feedback equation

$S_o = AS_\epsilon$

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

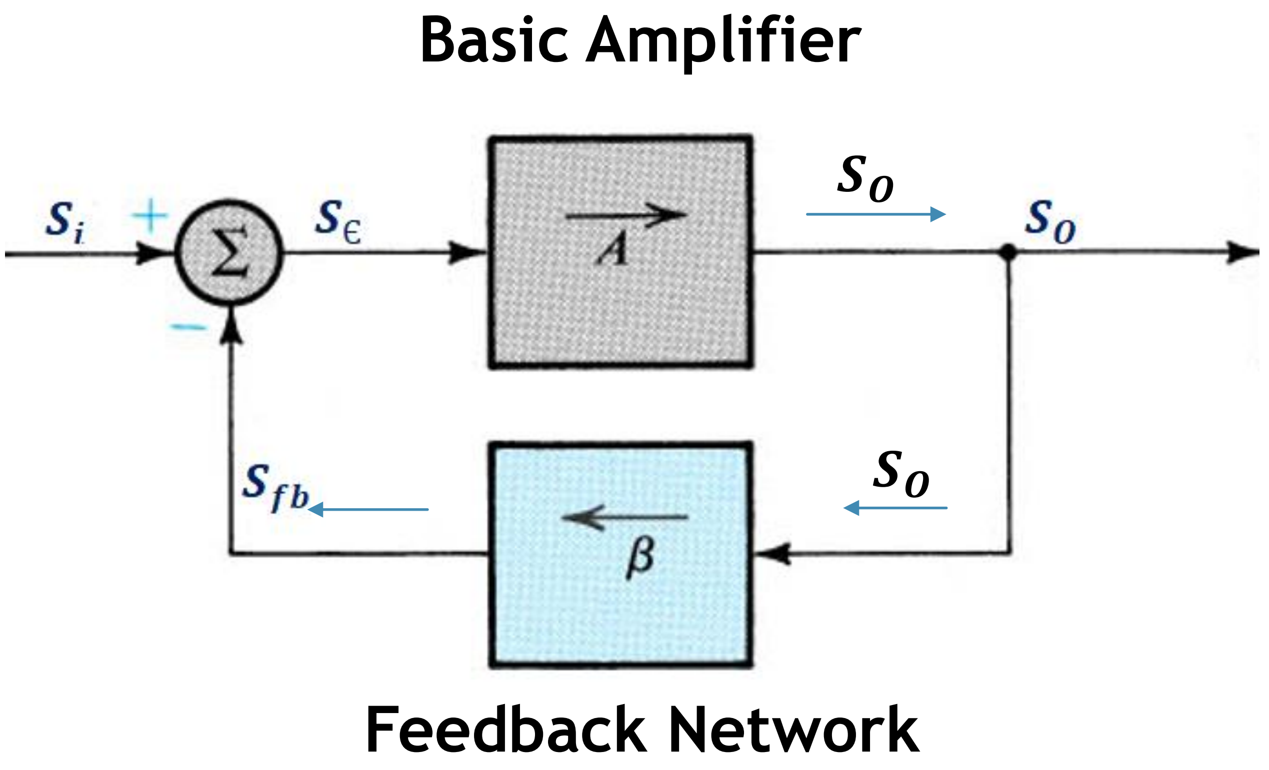
$S_{fb} = \beta \; S_o$

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

$A\beta \equiv$ Loop gain

If $A\beta \gg 1$

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



Negative Feedback

General Feedback equation

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

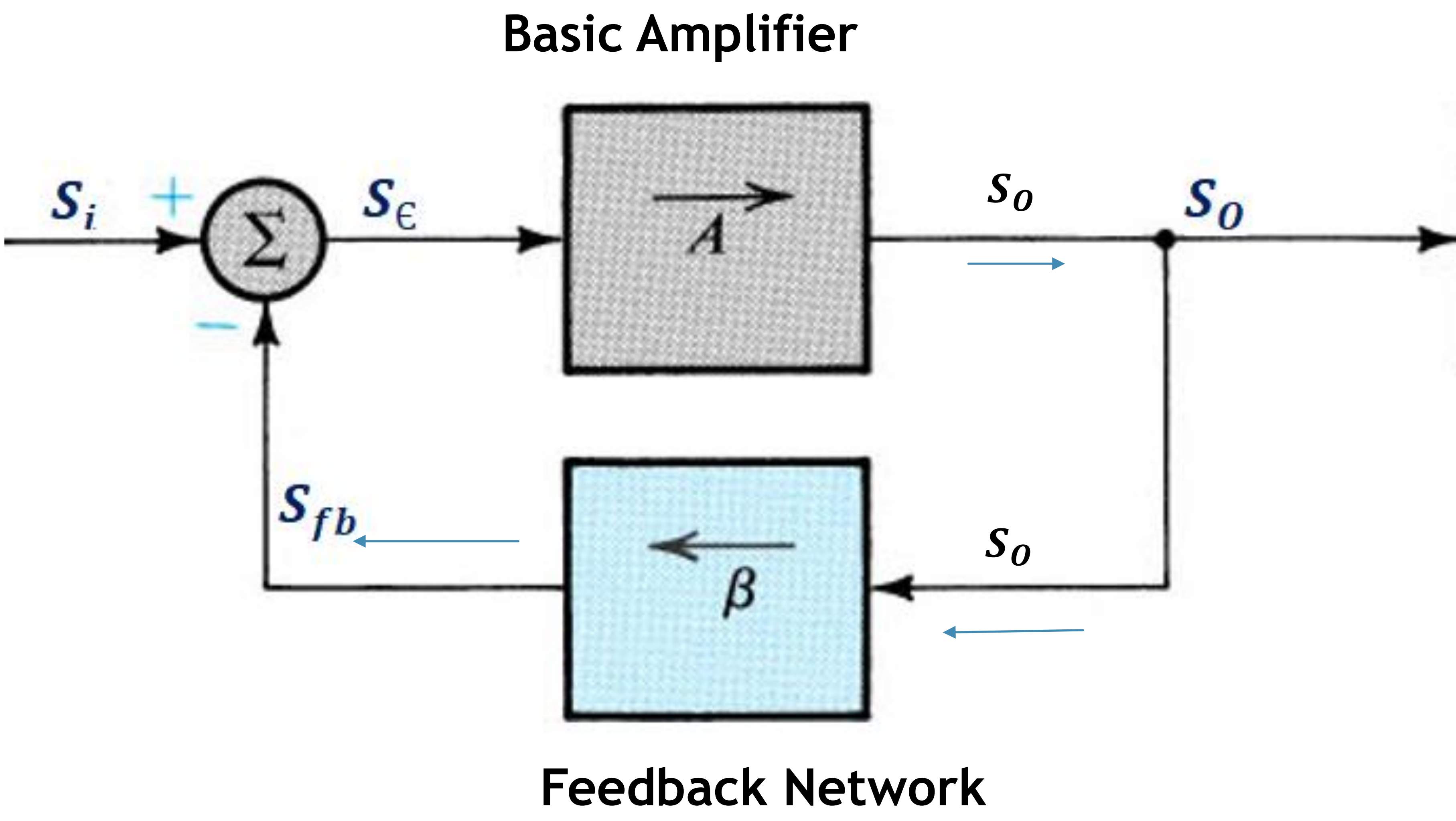
$S_\epsilon = S_i - \beta S_o$

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

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

If $A\beta \gg 1$

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



Gain stabilization

Negative Feedback

$$let\ A = 10,000$$

$$\beta = 0.01$$

$$\therefore A\beta = 100$$

$$Af = \frac{A}{1 + A\beta} = 99$$

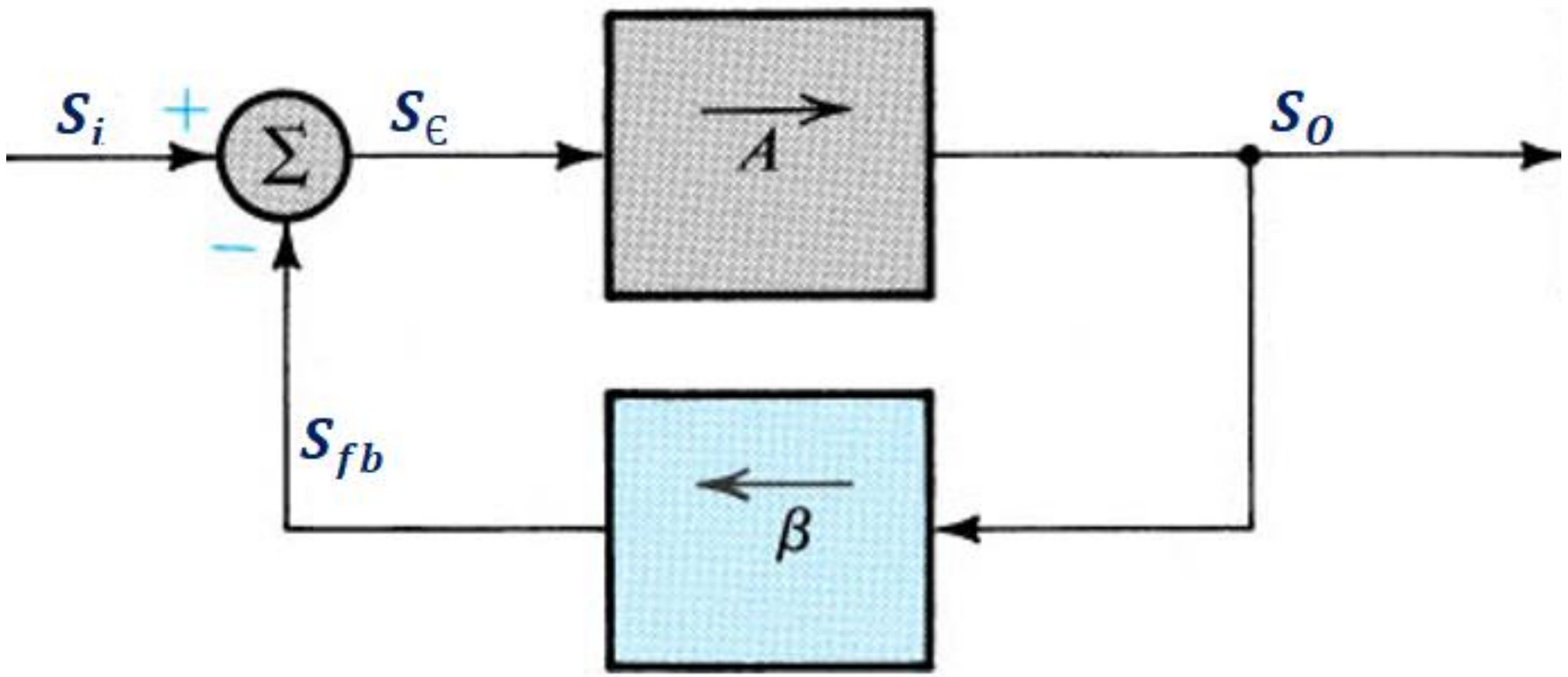
$$let\ A = 9000$$

$$\beta = 0.01$$

$$\therefore A\beta = 90$$

$$Af = \frac{A}{1 + A\beta} = 98.9$$

Basic Amplifier



Feedback Network

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

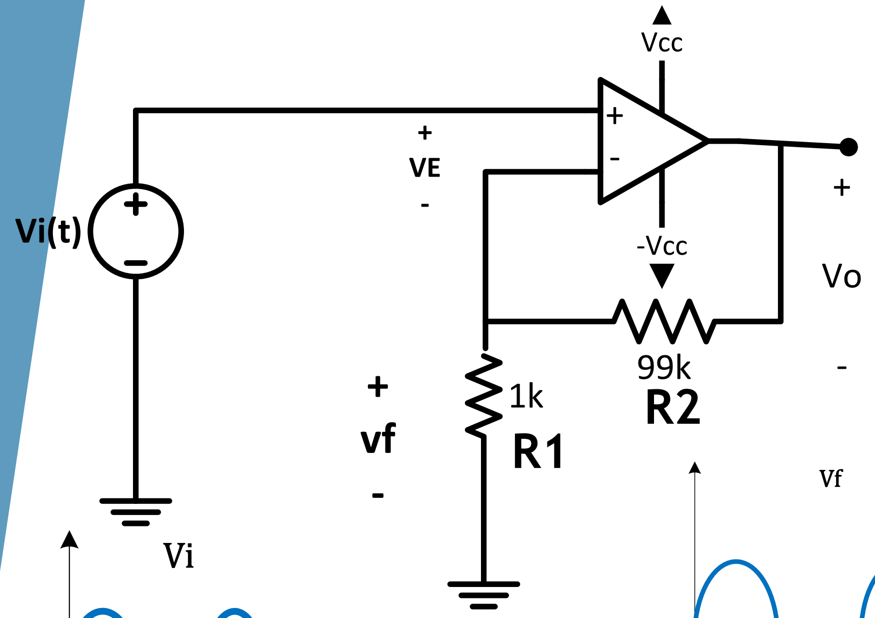
$$Af(jw) = \frac{A(jw)}{1 + A(jw)\beta}$$

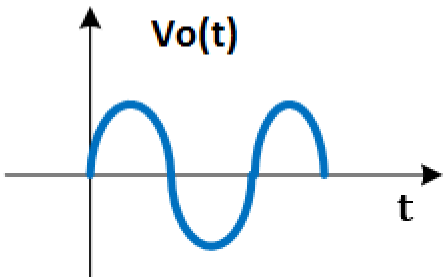
$$Af(jw) = \frac{A_m}{1 + A_m\beta} \cdot \frac{1}{1 + \frac{jw}{w2(1 + A_m\beta)}}$$

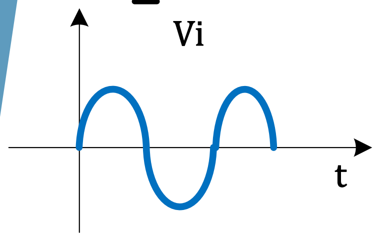
$$\therefore wH = w2(1 + A_m\beta)$$

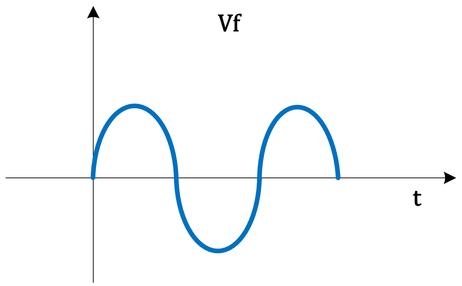
The Oscillation Problem

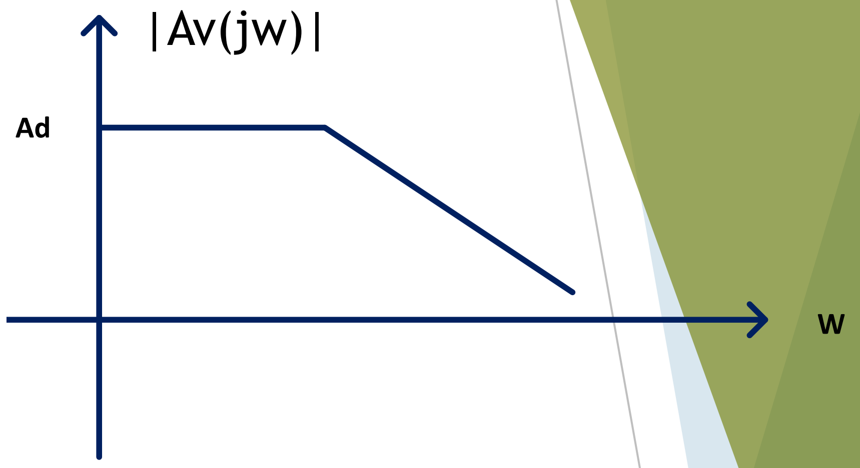
1)At mid band











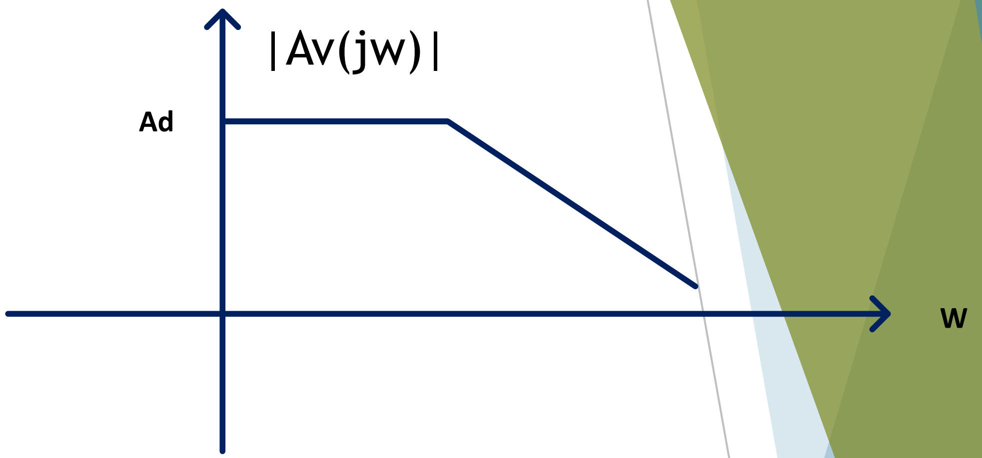
$$V_{\epsilon} = v_i - v_{fb} < v_i$$

Negative Feedback

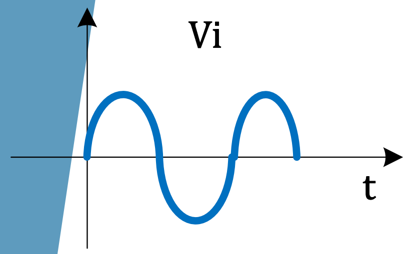
$$v_{fb} = \frac{R_1}{R_1+R_2} Vo$$

v_{fb} Opposes v_i

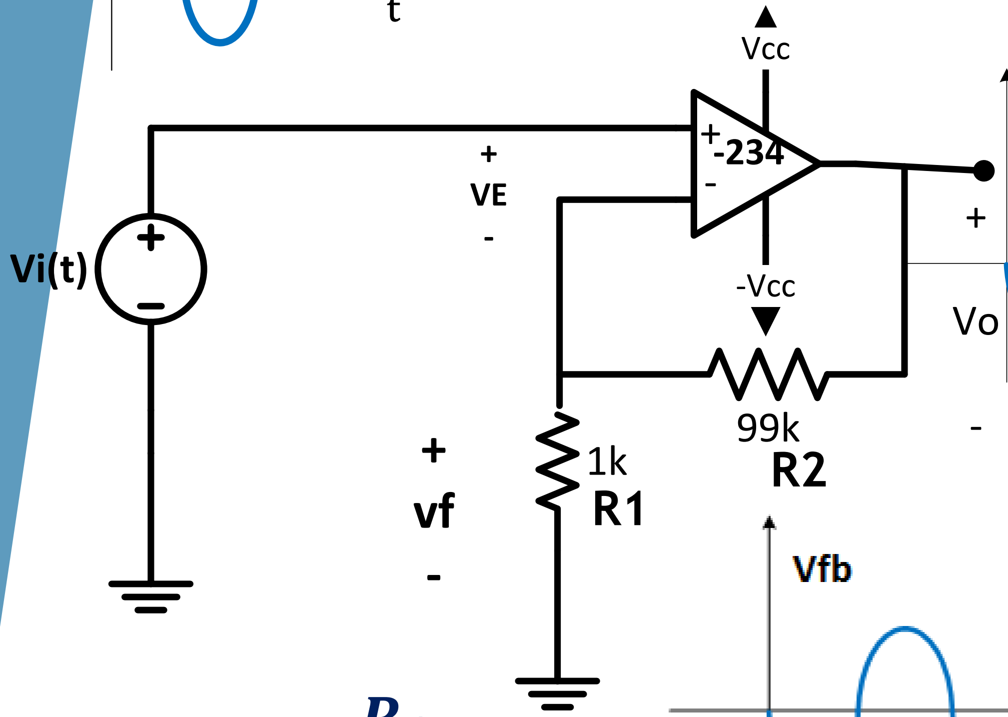
The Oscillation Problem

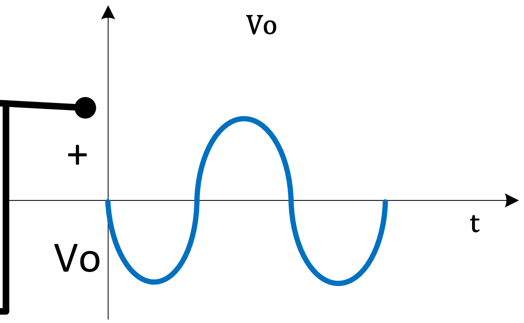


2)At High-frequency (phase = 180) at w0



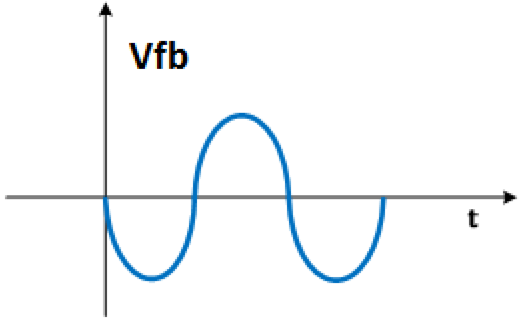
A = -234





$$V_\epsilon = v_i - v_{fb} > v_i$$

Positive Feedback



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

v_{fb} **adds to** v_i

The Oscillation Problem

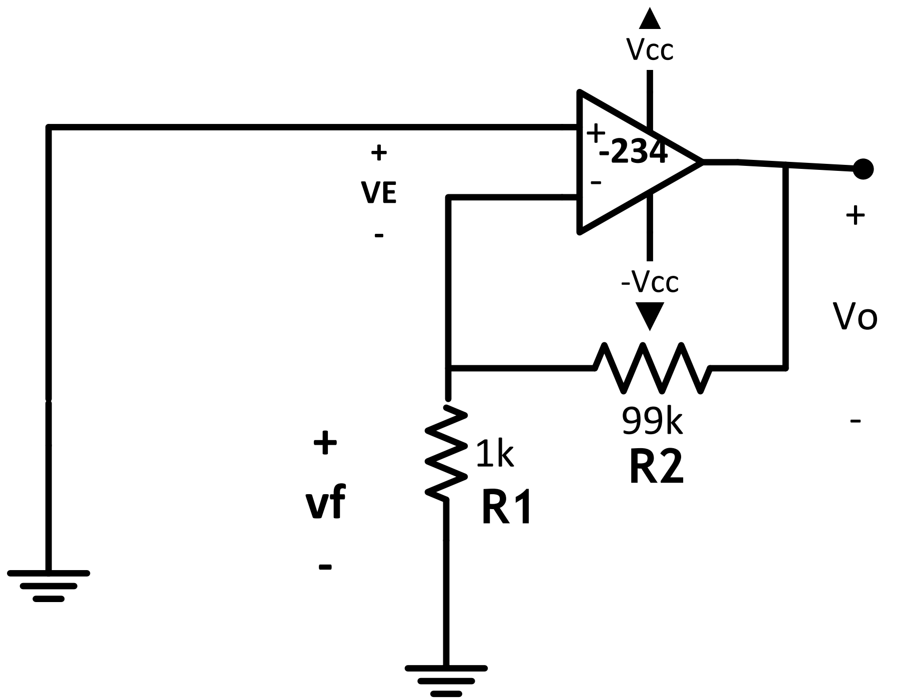
$$V_{\epsilon} = v_i - v_{fb}$$

Now let $v_i = 0$

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

$$V_o = \mathbf{A}V_{\epsilon}$$

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



The Oscillation Problem

A = -234

$V_o = AV_\epsilon$

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

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

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

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

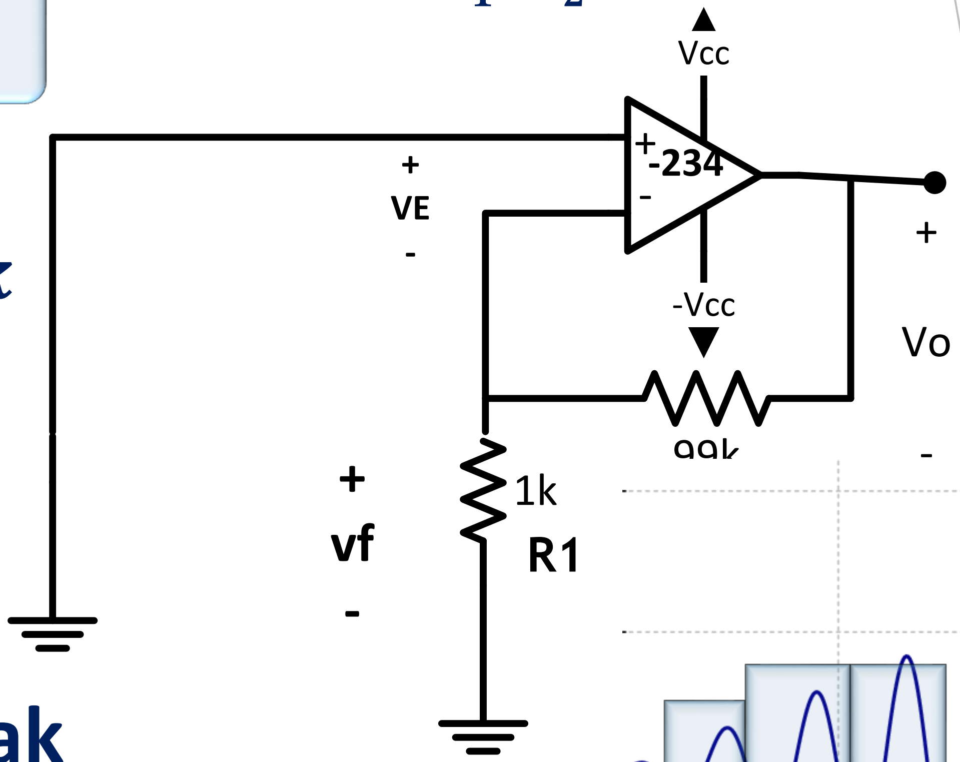
2. $V_{\epsilon 2} = -v_{fb1} = 2.34mV\ peak$

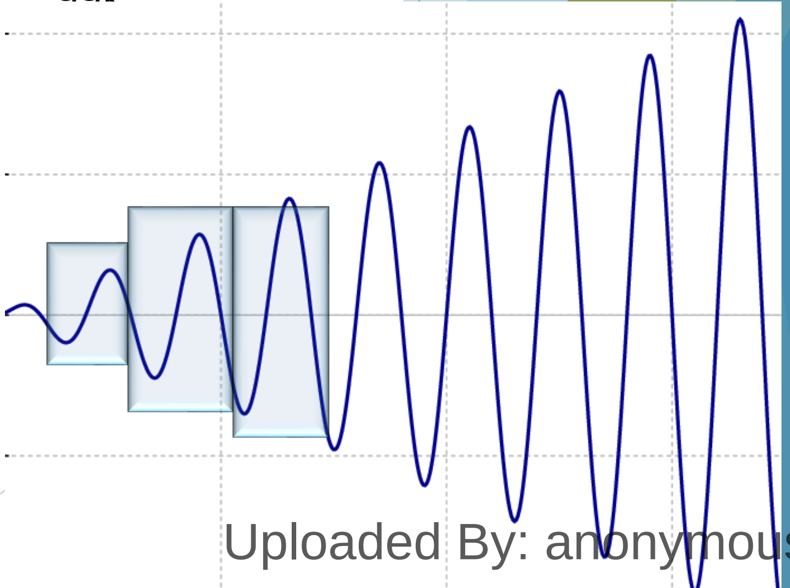
$V_{o2} =$ -548 mV peak

$V_{fb2} =$ -5.48 mV peak

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

$V_{o2} =$ 1.282V peak



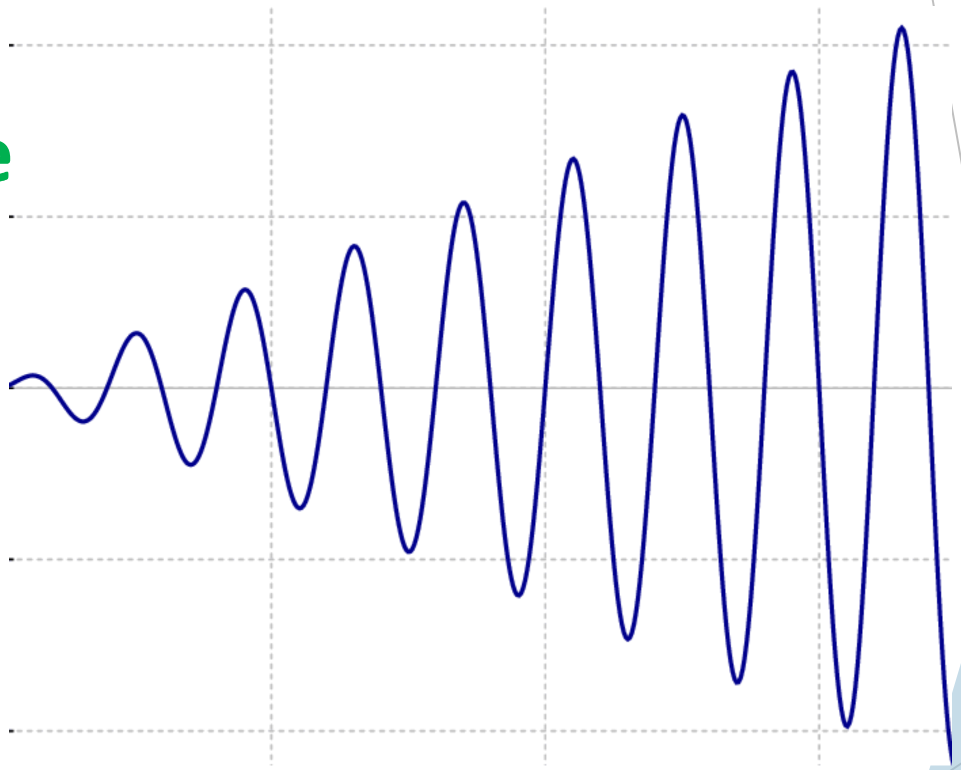


The Oscillation Problem

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

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

For Building up voltage



$$|V_{fb1}| > |V_{\epsilon 1}|$$

$$|\beta V_{o1}| > |V_{\epsilon 1}|$$

$$|A\beta V_{\epsilon 1}| > |V_{\epsilon 1}|$$

$$\therefore |A\beta| > 1$$

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

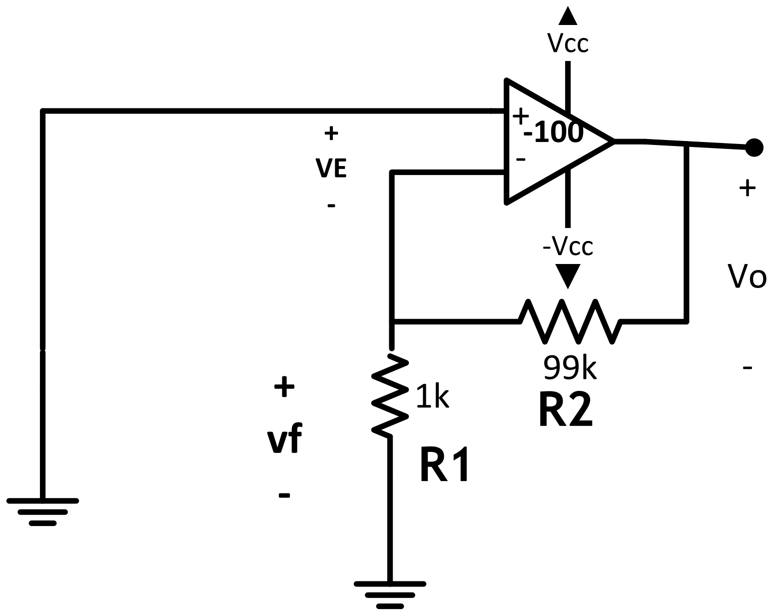
$V_{o2} = -$10V peak

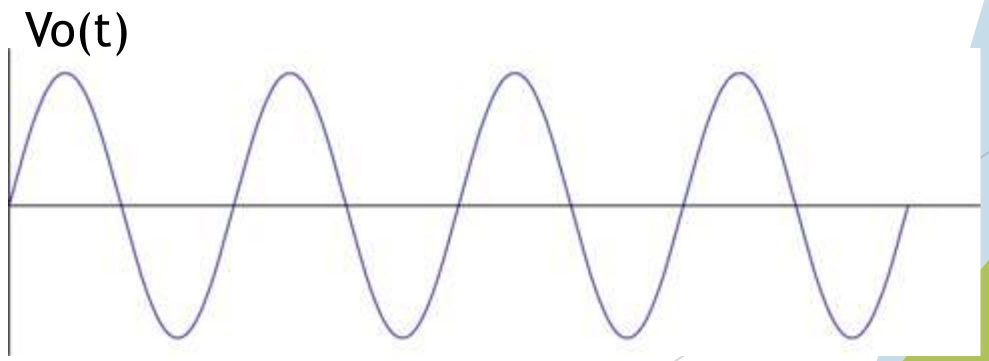
V_{fb2} = -100 mV peak

The out put signal is sustained

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

$|A\beta| = 1$





The Oscillation Problem

Now let change $R_2 = $ 299K

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

A = -234

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

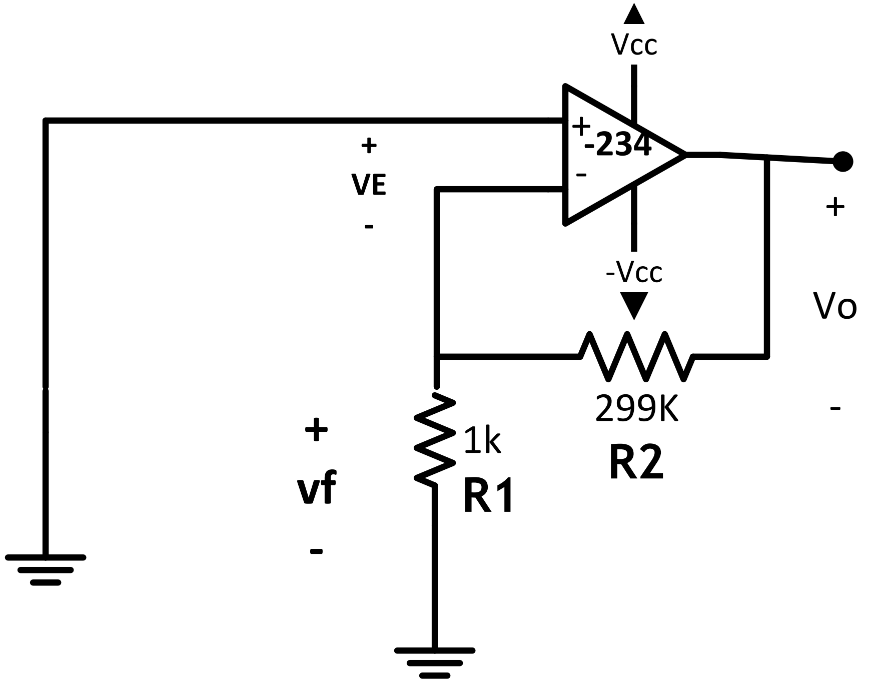
   $V_{o1} =$ - 234mV peak

   v_{fb1} = - 0.78 mV peak

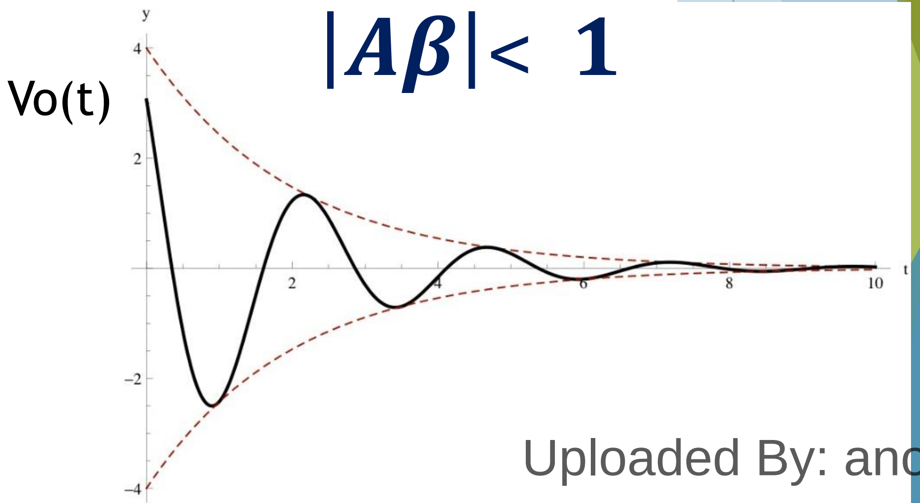
2. $V_{\epsilon 2} = -v_{fb1} = +0.78mV\ peak$

   $V_{o2} =$ - 182mV peak

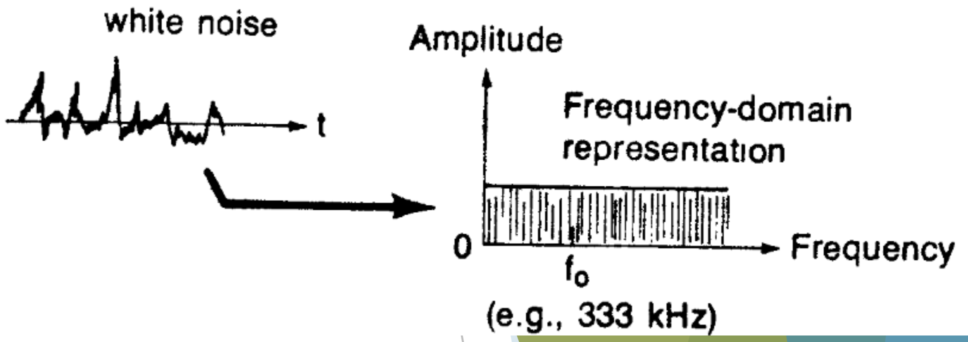
$\therefore\ V_\epsilon\ ,\ \ V_o\ ,v_{fb}$ are decreasing down



$|A\beta| < 1$



The Oscillation Problem

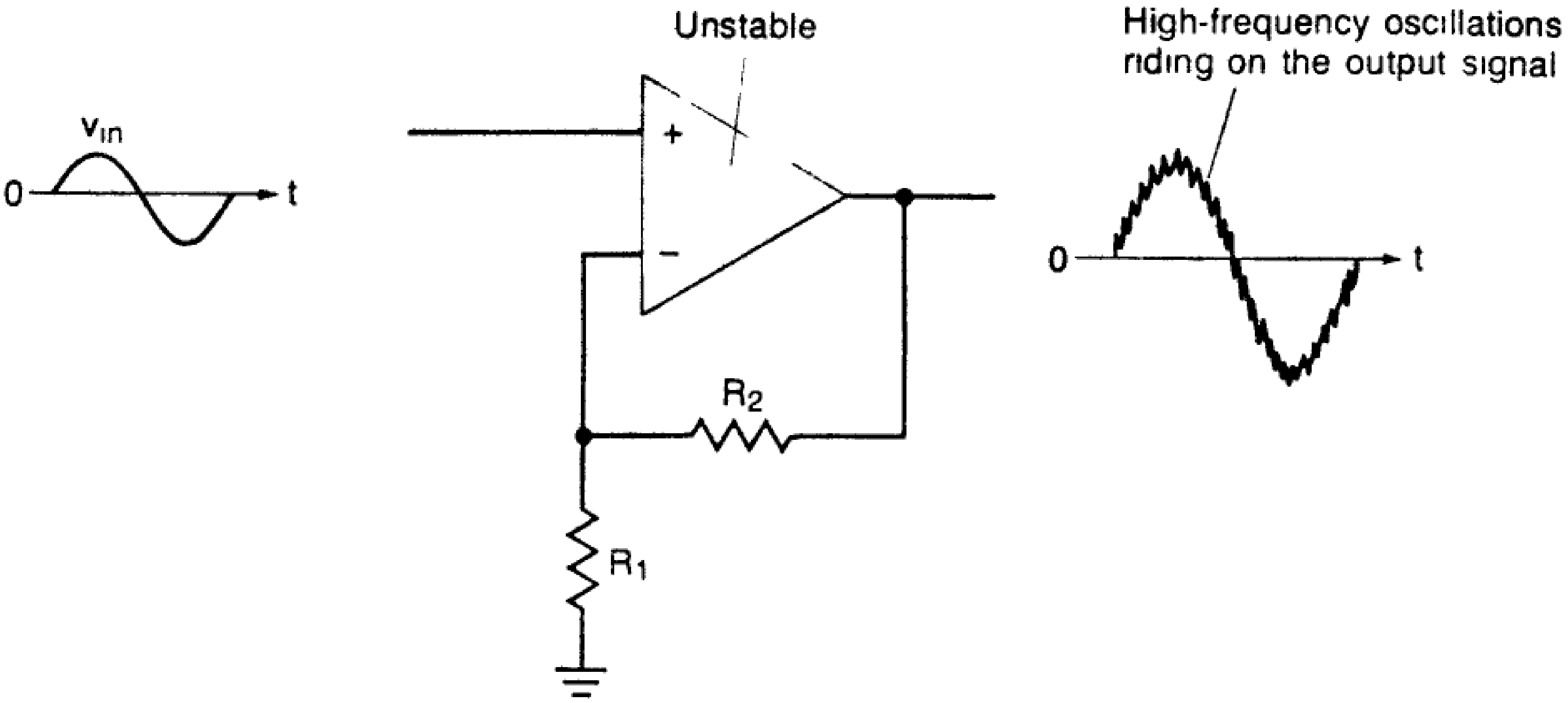


White noise

-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.



v_{in}
0
t
Unstable
+
−
R_2
R_1
High-frequency oscillations riding on the output signal
0
t