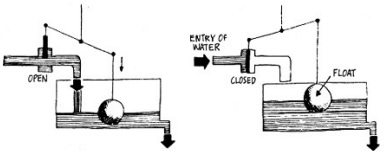
Feedback Techniques and Op-amps

Concept of feedback

Valve example



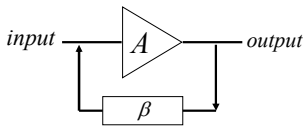
- **As the water nears the specified level, the valve is closed.**
- **Negative feedback is most commonly used to control systems.**

2

Types of feedback

What is feedback?

- ***Feedback is a technique where a proportion of the output of a system (amplifier) is fed back and recombined with input.***



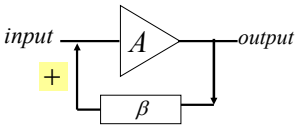
- **There are two types of feedback amplifier.**
  - ***Positive feedback***
  - ***Negative feedback***

3

Types of feedback..

1.Positive Feedback

- **Positive feedback is the process when the output is *added* to the input, amplified again, and this process continues.**



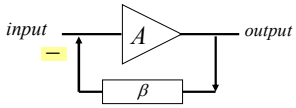
- **<u>Example</u>: In a PA system, you get feedback when you put the microphone in front of a speaker and the sound gets uncontrollably loud (you have probably heard this unpleasant effect).**

4

Types of feedback..

2. Negative Feedback

- **Negative feedback is when the output is subtracted from the input.**

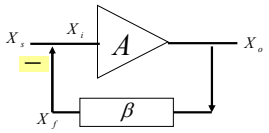


- **Example: Speed control. If the car starts to speed up above the desired set-point speed, negative feedback causes the throttle to close, thereby reducing speed; similarly, if the car slows, negative feedback acts to open the throttle.**
- **The use of negative feedback reduces the gain. Part of the output signal is taken back to the input with a negative sign.**

5

Types of feedback..

Negative Feedback Gain



The gain with feedback (or closed-loop gain) A_f as follows:

$$X_o = A.X_i \qquad X_i = X_s - X_f \qquad X_f = \beta.X_o$$

$$A_f = \frac{X_o}{X_s} = \frac{A}{1+\beta A}$$

The quantity βA is called the loop gain, and the quantity (1+βA) is called the amount of feedback.

6

Advantages of Negative Feedback

1. ***Stabilization of gain***
   - **make the gain less sensitive to changes in circuit components e.g. due to changes in temperature.**
2. ***Reduce non-linear distortion***
   - **make the output proportional to the input, keeping the gain constant, independent of signal level.**
3. ***Reduce the effect of noise***
   - **minimize the contribution to the output of unwanted signals generated in circuit components or extraneous interference.**

7

Advantages of Negative Feedback....

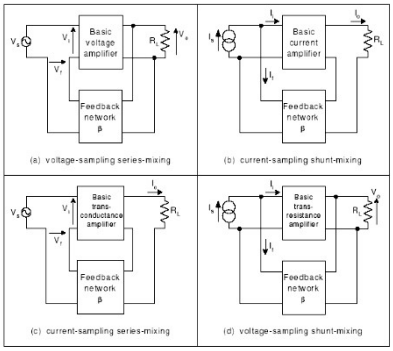
4. ***Extend the bandwidth of the amplifier***
   - **Reduce the gain and increase the bandwidth**
5. ***Modification the input and output impedances***
   - **raise or lower the input and output impedances by selection of the appropriate feedback topology.**

Disadvantages of Negative Feedback

1. ***Circuit gain - Reduce***
2. ***Stability – Tend to be oscillate***

8

Feedback Amplifier Topologies



Feedback Topologies

Feedback relationship

	Gain	Input resistance	Output resistance
Without feedback	**A**	$\mathbf{R_i}$	$\mathbf{R_o}$
Series-shunt	$A_f = \frac{A}{1+\beta A}$	$R_{if} = R_i(1+\beta A)$	$R_{of} = \frac{R_o}{1+\beta A}$
Series-series	$A_f = \frac{A}{1+\beta A}$	$R_{if} = R_i(1+\beta A)$	$R_{of} = R_o(1+\beta A)$
Shunt-shunt	$A_f = \frac{A}{1+\beta A}$	$R_{if} = \frac{R_i}{1+\beta A}$	$R_{of} = \frac{R_o}{1+\beta A}$
Shunt-series	$A_f = \frac{A}{1+\beta A}$	$R_{if} = \frac{R_i}{1+\beta A}$	$R_{of} = R_o(1+\beta A)$