Feedback and its Applications

LECTURE 6 OSCILLATOR

- Introduction of Oscillator
- Linear Oscillator
  - Wien Bridge Oscillator
  - RC Phase-Shift Oscillator
  - LC Oscillator
- Stability

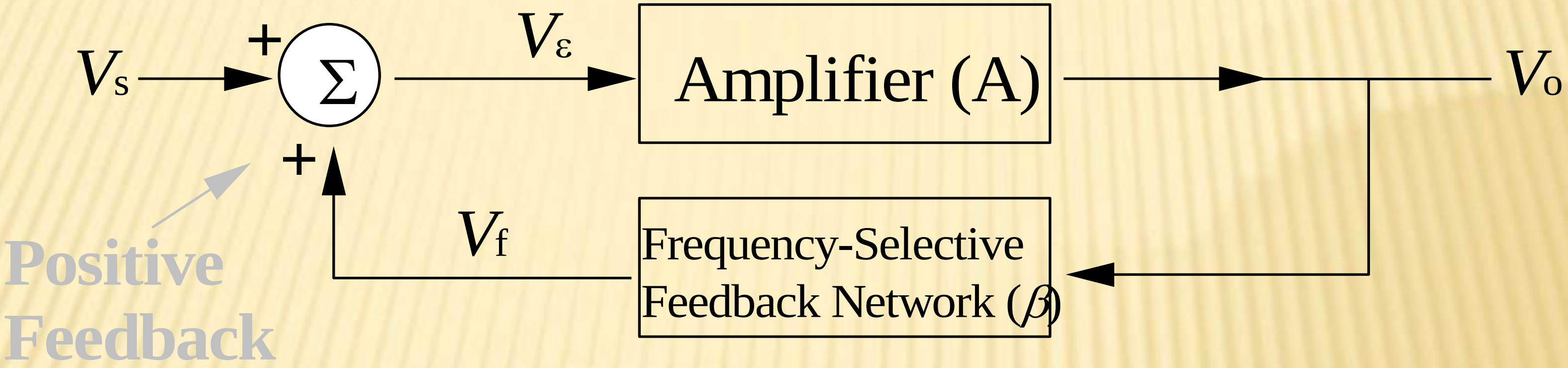
APPLICATION OF OSCILLATORS

- Oscillators are used to generate signals, e.g.
  - Used as a local oscillator to transform the RF signals to IF signals in a receiver;
  - Used to generate RF carrier in a transmitter
  - Used to generate clocks in digital systems;
  - Used as sweep circuits in TV sets and CRO.

LINEAR OSCILLATORS

1. Wien Bridge Oscillators
2. RC Phase-Shift Oscillators
3. LC Oscillators
4. Stability

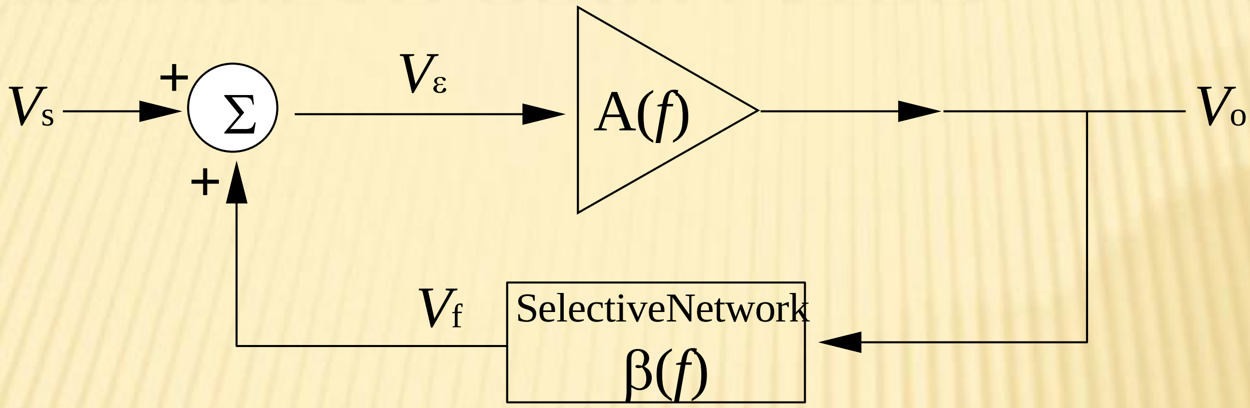
INTEGRANT OF LINEAR OSCILLATORS



For sinusoidal input is connected
"Linear" because the output is approximately sinusoidal

<u>A linear oscillator contains:</u>
- a frequency selection feedback network
- an amplifier to maintain the loop gain at **unity**

BASIC LINEAR OSCILLATOR



$$V_o = AV_\varepsilon = A(V_s + V_f) \quad \text{and} \quad V_f = \beta V_o$$

$$\Rightarrow \frac{V_o}{V_s} = \frac{A}{1 - A\beta}$$

If $V_s = 0$, the only way that V_o can be nonzero is that loop gain $A\beta=1$ which implies that

$$|A\beta| = 1$$

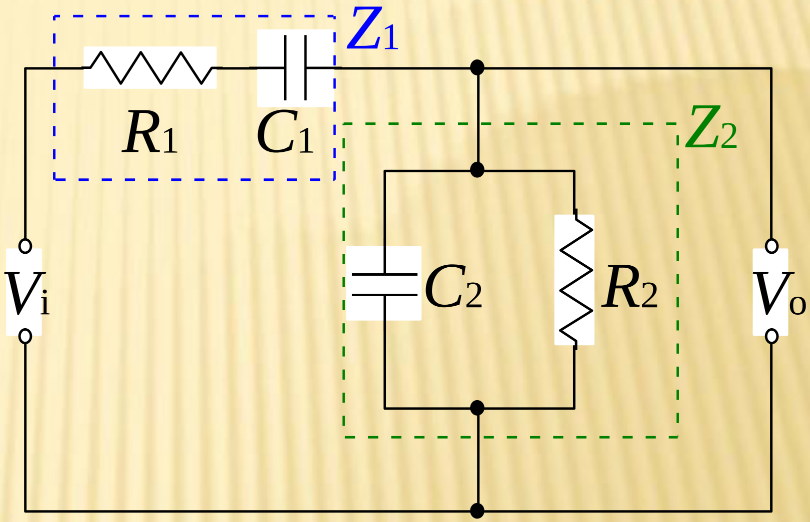
$$\angle A\beta = 0$$

(Barkhausen Criterion)

WIEN BRIDGE OSCILLATOR

Let $X_{C1} = \dfrac{1}{\omega C_1}$ and $X_{C2} = \dfrac{1}{\omega C_2}$

Frequency Selection Network



$$Z_1 = R_1 - jX_{C1}$$

$$Z_2 = \left[\frac{1}{R_2} + \frac{1}{-jX_{C2}}\right]^{-1} = \frac{-jR_2 X_{C2}}{R_2 - jX_{C2}}$$

Therefore, the feedback factor,

$$\beta = \frac{V_o}{V_i} = \frac{Z_2}{Z_1 + Z_2} = \frac{(-jR_2 X_{C2} / R_2 - jX_{C2})}{(R_1 - jX_{C1}) + (-jR_2 X_{C2} / R_2 - jX_{C2})}$$

$$\beta = \frac{-jR_2 X_{C2}}{(R_1 - jX_{C1})(R_2 - jX_{C2}) - jR_2 X_{C2}}$$

β can be rewritten as:

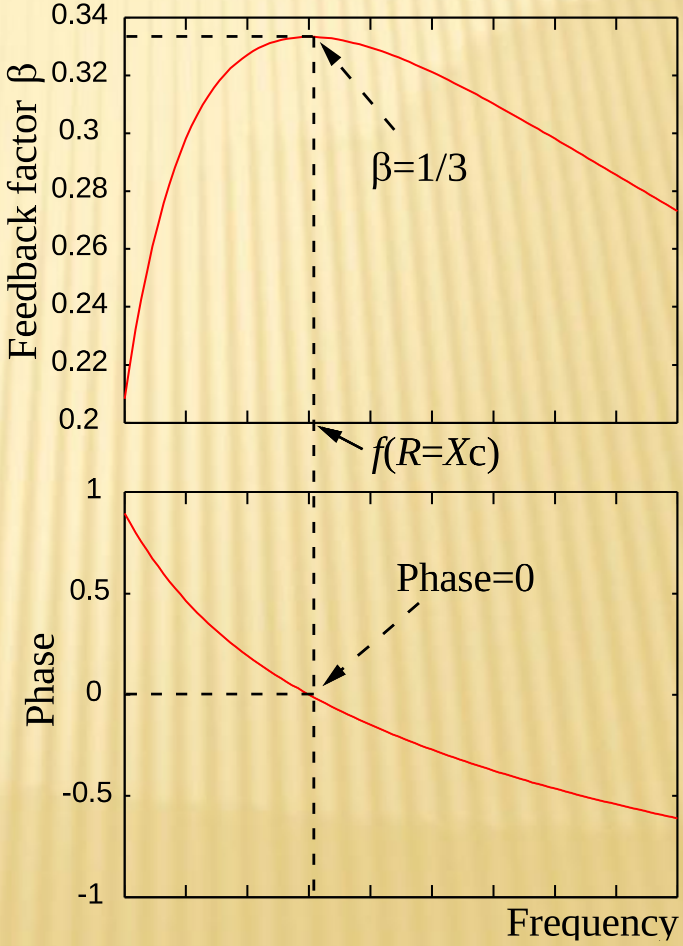
$$\beta = \frac{R_2 X_{C2}}{R_1 X_{C2} + R_2 X_{C1} + R_2 X_{C2} + j(R_1 R_2 - X_{C1} X_{C2})}$$

For ***Barkhausen Criterion***, imaginary part = 0, i.e.,

$$R_1 R_2 - X_{C1} X_{C2} = 0$$

$$\text{or} \quad R_1 R_2 = \frac{1}{\omega C_1} \frac{1}{\omega C_2}$$

$$\Rightarrow \omega = 1/\sqrt{R_1 R_2 C_1 C_2}$$



Supposing,

R_1=R_2=R and X_{C1}= X_{C2}=X_C,

$$\beta = \frac{R X_C}{3 R X_C + j(R^2 - X_C^2)}$$