Oscillators- Condition for oscillations

An oscillator may be described as a source of alternating voltage. It is different than amplifier. An amplifier delivers an output signal whose waveform corresponds to the input signal but whose power level is higher. The additional power content in the output signal is supplied by the DC power source used to bias the active device.

The amplifier can therefore be described as an energy converter, it accepts energy from theDC power supply and converts it to energy at the signal frequency. The process of energy conversion is controlled by the input signal, Thus if there is no input signal, no energy conversion takes place and there is no output signal.

The oscillator, on the other hand, requires no external signal to initiate or maintain the energy conversion process. Instead an output signals is produced as long as source of DCpower is connected. Fig. 1, shows the block diagram of an amplifier and an oscillator.

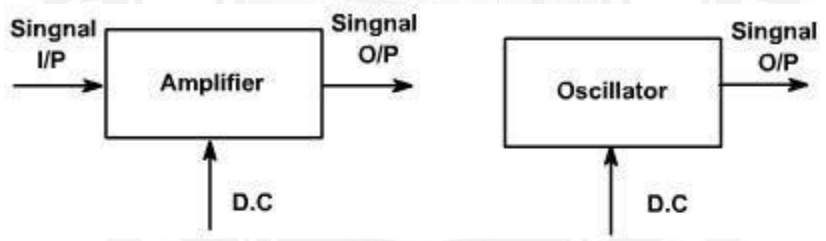

Fig..1 amplifier Oscillators
[Source: "Electronic devices and circuits" by "Balbir Kumar, Shail.B.Jain,]

Oscillators may be classified in terms of their output waveform, frequency range components, or circuit configuration.

If the output waveform is sinusoidal, it is called harmonic oscillator otherwise it is called relaxation oscillator, which include square, triangular and saw tooth waveforms.

Oscillators employ both active and passive components. The active components provide energy conversion mechanism. Typical active devices are transistor, FET etc.

Passive components normally determine the frequency of oscillation. They also influence

stability, which is a measure of the change in output frequency (drift) with time, temperature or other factors. Passive devices may include resistors, inductors, capacitors, transformers, and resonant crystals. Capacitors used in oscillator's circuits should be of high quality.

Types of Oscillators:

- There are many types of oscillators, but can broadly be classified into two main categories
- Harmonic Oscillators (also known as Linear Oscillators) and
- Relaxation Oscillators.
- In a harmonic oscillator, the energy flow is always from the active components to the passive components and the frequency of oscillations is decided by the feedback path.
- Whereas in a relaxation oscillator, the energy is exchanged between the active and the passive components and the frequency of oscillations is determined by the charging and discharging time-constants involved in the process.
- Further, harmonic oscillators produce low-distorted sine-wave outputs
- while the relaxation oscillators generate non-sinusoidal (saw- tooth, triangular or square) wave-forms. Sinusoidal or non-sinusoidal.

◆ An oscillator generating square wave or a pulse train is called multivibrator :

1. Bistable multivibrator (Flip-Flop Circuit).
2. Monostable multivibrator.
3. Astable multivibrator (Free-running).

- Depending upon type of feedback, we have
  1. Tuned Circuit (LC) oscillators.
  2. RC oscillators, and
  3. Crystal oscillators.

The main types of Oscillators include:

1. RC Oscillators
   - Wien Bridge Oscillator
   - RC Phase Shift Oscillator
2. LC Oscillators
   i. Hartley Oscillator
   ii. Colpitts Oscillator
   iii. Clapp Oscillator
3. Crystal Oscillators

Barkhausen Criteria

- The condition **Aβ=1** is known as Barkhausen criteria. It implies

(1) Magnitude of the loop gain **Aβ = 1**

(2) Phase shift over the loop = 0 0r 360 degrees.

- Frequency of the noise in the amplifier for which this criteria are satisfied, is the frequency of oscillations.
- By applying this criteria, we can even find the values of transistor parameters, like gain, required for setting in oscillations.

Damped Oscillations

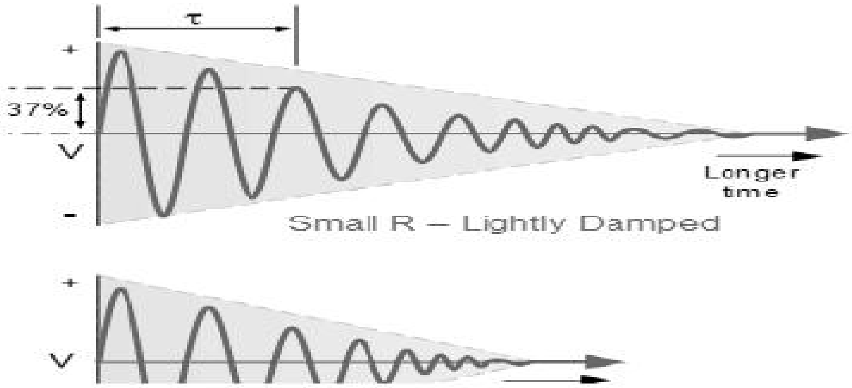

Fig. 2 Damped Oscillations

[Source: "Electronic devices and circuits" by "Balbir Kumar, Shail.B.Jain,]

The frequency of the oscillatory voltage depends upon the value of the inductance and capacitance in the LC tank circuit. We now know that for resonance to occur in the tank circuit, there must be a frequency point were the value of XC, the capacitive reactance is the same as the value of XL, the inductive reactance (XL = XC) and which will therefore cancel out each other out leaving only the DC resistance in the circuit to oppose the flow of current.

If we now place the curve for inductive reactance on top of the curve for capacitive reactance so that both curves are on the same axes, the point of intersection will give us the resonance frequency point, (fr or ωr).