CHAPTER 6

OSCILLATORS

Course Instructor (2EA)

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CHAPTER OUTLINE

- A.C .Signal Sources
- Oscillators Introduction
- Difference between amplifier and oscillators
- Frequency Stability of Oscillator
- Principle Of Oscillator
- Barkhausen Criterion
- RC Oscillators
- LC Oscillators
- Astable Multivibrators
- **Square Wave Generators**
- **Triangular Wave generators**
- 555 Timers

A.C. Signal Sources

- Required for troubleshooting, designing of electronic circuits and systems
- Indispensable tool in R&D of electronics and Communication engineering

Desirable Properties

- Low harmonic Content
- Stable Operating frequency
- Stable Output amplitude
- Low noise

Oscillator

- Basic element of all ac signal sources
- Generates repetitive waveform of fixed frequency and amplitude
- Oscillators are also used in
  - Superheterodyne receivers
  - Clock Pulse in digital circuits
  - Sweep units in TV sets, Oscilloscopes

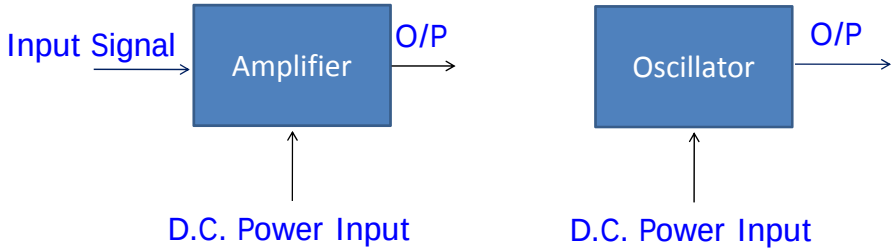
Diff. betⁿ Oscillator and Amplifier

Amplifier

- Output signal changes with the change in input signal

Oscillator

- No input signal is required



Oscillators

- Oscillators obey law of conservation of energy
- Oscillators merely acts as energy converters
- Converts the unidirectional current drawn from a d.c. source of supply into alternating current of desired frequency
- Oscillators are also called inverters and are opposite to rectifiers
- In Instrumentation Oscillators are also known by different names such as function generators, test oscillators …..

Oscillator Types

- Oscillators can be categorized according to
  - Type of component used (RC, LC, Crystal)
  - Frequency of Oscillation (AF, RF)
  - Type of waveform generated (Sinusoidal, Square Wave, Triangular Wave, Sawtooth Wave)

Frequency Stability of Oscillator

- Measure of the oscillator's ability to maintain a constant frequency over as long interval of time as possible
- Practically, there are some factors that affect the frequency stability of Oscillator

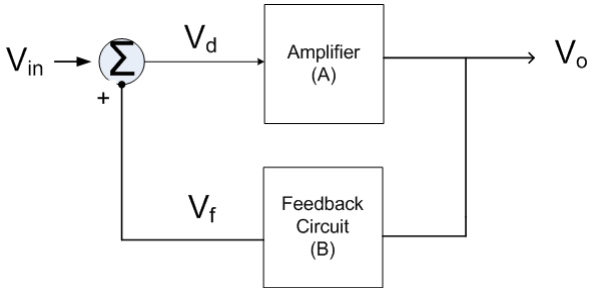
Factors Affecting Frequency Stabilty

- Circuit Components
  - Values of R, L and C changes with temperature
- Transistor Parameters
  - Variation in temperature causes variation in transistor parameters

Factors Affecting Frequency stability of an Oscillator (contd…)

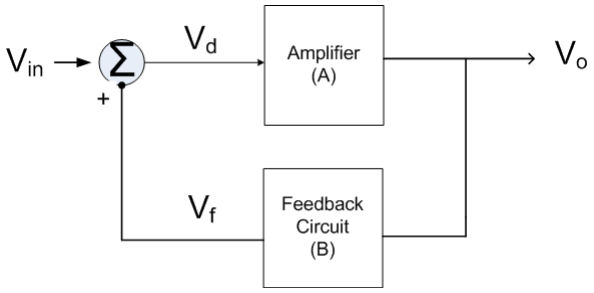
- Supply Voltages
  - Variations in power supply
- Stray Capacitances
- Output Load
  - Variations of load causes a change in effective resitance
- Inter-element Capacitance

Principle of Oscillator



- An oscillator can be considered as a **feedback amplifier** in which part of the output is fed back to the input via a feedback circuit. If the signal is of **proper magnitude and phase**, the circuit produces alternating voltages or currents.

Derivation of Voltage Gain in a Positive feedback circuit



- $V_d=V_f+V_{in}$
- $V_{in}=V_d-V_f$ i
- $V_o=AV_d$.....ii
- $V_f=BV_o$.....iii

Determine V_o/V_{in} in terms of A and B ?

Derivation (continued.....)

Equations

- $V_d=V_f+V_{in}$
- $V_{in}=V_d-V_f$ i
- $V_o=AV_d$.....ii
- $V_f=BV_o$.....iii

$$\frac{V_0}{V_{in}} = \frac{AV_d}{V_d - V_f} = \frac{AV_d}{V_d - BV_0} = \frac{A}{1-AB} \left[since, \frac{Vo}{Vd} = A\right]$$

Barkhausen Criterion

- The overall voltage gain for a positive feedback amplifier is given as,

$$\frac{V_0}{V_{in}} = \frac{A}{1-AB}$$

- V_{in} is zero for Oscillator
- i.e. *1-AB=0, i.e. AB=1*
- This condition needs to fulfilled for Sustained Oscillations and is called the Barkhausen Criterion

Barkhausen Criterion (contd….)

- When AB=1 is expressed in polar form,

$$AB=1 \angle 0^\circ \; or \; 360^\circ$$

- The above equation gives two requirements for oscillations

i) The magnitude of AB must be equal to 1.

ii) The total phase shift of the loop gain AB must be equal to 0 or 360 degrees

Oscillator Illustration

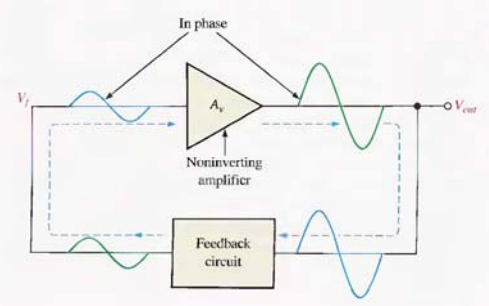


Fig.1 Oscillator Action

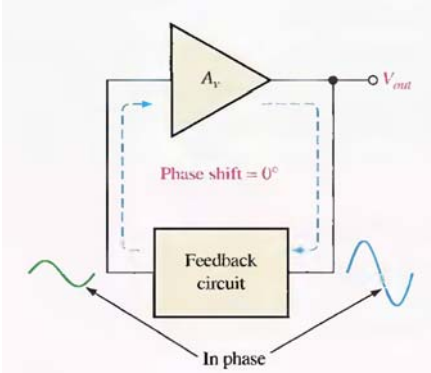


Fig.2 The phase shift around the loop is zero

Questions ??

- If the oscillator is initially off and there is no output voltage then how does a feedback signal originate to start the positive feedback build up process?
- For those students who were absent during the last class email the answer to coursekec@gmail.com and win bonus marks

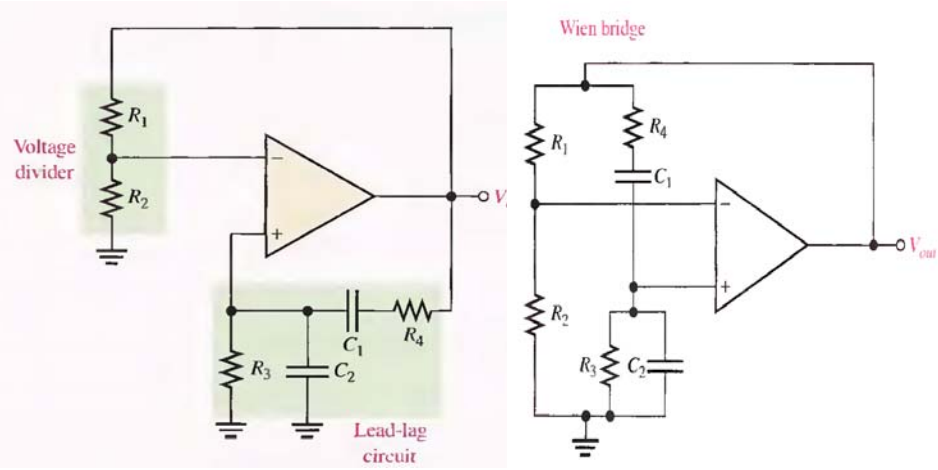
RC Oscillators

- Uses RC circuits to produce oscillations
- In the chapter we'll dealing with the following RC Oscillators
  - Wien Bridge Oscillator
  - Phase Shift Oscillator

Wien Bridge Oscillator

- In any oscillator circuit, the total phase shift around the closed loop should be either zero or 360 degrees.
- In Wien Bridge oscillator amplifying as well as the frequency determining network both introduce zero phase shift.
- This is the basic principle of Wien Bridge Oscillator

Wien Bridge……



Wien Bridge Oscillator Circuit

Lead Lag Circuit

- It's a fundamental circuit in Wien Bridge Oscillator