7. In Fig. 13.31, if input and output impedances without feedback are 2 MΩ and 500 Ω respectively, find their values after negative voltage feedback. **[302MΩ; 1.6Ω]**
8. An amplifier has a current gain of 240 without feedback. When negative current feedback is applied, determine the effective current gain of the amplifier. Given that current attenuation $m_i = 0.015$. **[52.7]**
9. An amplifier has an open-loop gain and input impedance of 200 and 15 kΩ respectively. If negative current feedback is applied, what is the effective input impedance of the amplifier? Given that current attenuation $m_i = 0.012$. **[4.41 kΩ]**
10. An amplifier has $A_i = 200$ and $m_i = 0.012$. The open-loop output impedance of the amplifier is 2kΩ. If negative current feedback is applied, what is the effective output impedance of the amplifier ? **[6.8 kΩ]**

## Discussion Questions

1. Why is negative voltage feedback employed in high gain amplifiers ?
2. How does negative voltage feedback increase bandwidth of an amplifier ?
3. Feedback for more than three stages is seldom employed. Explain why ?
4. Why is emitter follower preferred to transformer for impedance matching ?
5. Where is emitter follower employed practically and why ?
6. What are the practical applications of emitter follower ?

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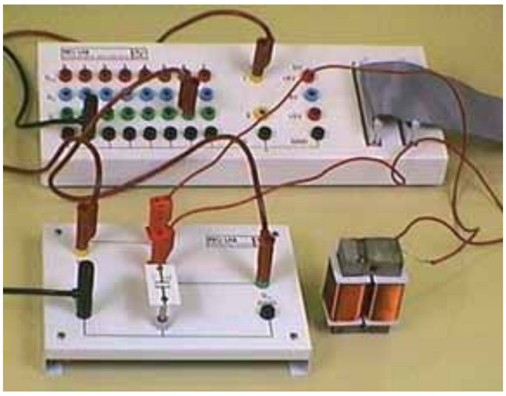
# 14

# Sinusoidal Oscillators





## INTRODUCTION

Many electronic devices require a source of energy at a specific frequency which may range from a few Hz to several MHz. This is achieved by an electronic device called an *oscillator*. Oscillators are extensively used in electronic equipment. For example, in radio and television receivers, oscillators are used to generate high frequency wave (called *carrier wave*) in the tuning stages. Audio frequency and radio-frequency signals are required for the repair of radio, television and other electronic equipment. Oscillators are also widely used in radar, electronic computers and other electronic devices.

Oscillators can produce sinusoidal or non-sinusoidal (*e.g.* square wave) waves. In this chapter, we shall confine our attention to sinusoidal oscillators *i.e.* those which produce sine-wave signals.

## 14.1 Sinusoidal Oscillator

*An electronic device that generates sinusoidal oscillations of desired frequency is known as a* ***sinusoidal oscillator.**

Although we speak of an oscillator as "generating" a frequency, it should be noted that it does not create energy, but merely acts as an energy converter. It receives d.c. energy and changes it into a.c. energy of desired frequency. The frequency of oscillations depends upon the constants of the device.

It may be mentioned here that although an alternator produces sinusoidal oscillations of 50Hz, it cannot be called an oscillator. Firstly, an alternator is a mechanical device having rotating parts whereas an oscillator is a non-rotating electronic device. Secondly, an alternator converts mechanical energy into a.c. energy while an oscillator converts d.c. energy into a.c. energy. Thirdly, an alternator cannot produce high frequency oscillations whereas an oscillator can produce oscillations ranging from a few Hz to several MHz.

***Advantages***

Although oscillations can be produced by mechanical devices (*e.g.* alternators), but electronic oscillators have the following advantages :

(*i*) An oscillator is a non-rotating device. Consequently, there is little wear and tear and hence longer life.

(*ii*) Due to the absence of moving parts, the operation of an oscillator is quite silent.

(*iii*) An oscillator can produce waves from small (20 Hz) to extremely high frequencies (> 100 MHz).

(*iv*) The frequency of oscillations can be easily changed when desired.

(*v*) It has good frequency stability *i.e.* frequency once set remains constant for a considerable period of time.

(*vi*) It has very high efficiency.

## 14.2 Types of Sinusoidal Oscillations

Sinusoidal electrical oscillations can be of two types *viz damped oscillations* and *undamped oscillations*.

(*i*) **Damped oscillations.** The electrical oscillations whose amplitude goes on decreasing with time are called *damped oscillations*. Fig. 14.1 (*i*) shows waveform of damped electrical oscillations. Obviously, the electrical system in which these oscillations are generated has losses and some energy is lost during each oscillation. Further, no means are provided to compensate for the losses and consequently the amplitude of the generated wave decreases gradually. It may be noted that frequency of oscillations remains unchanged since it depends upon the constants of the electrical system.

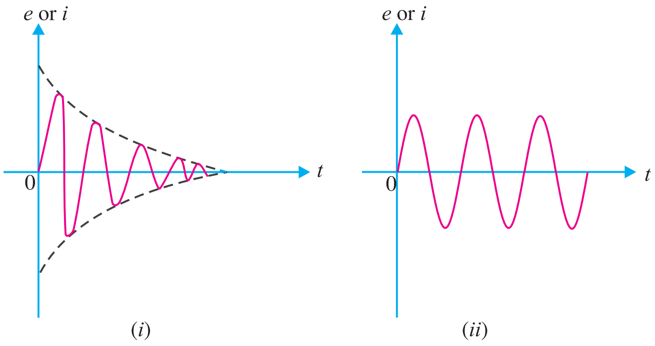



**Fig. 14.1**

* Note that oscillations are produced without any external signal source. The only input power to an oscillator is the d.c. power supply.

**(*ii*) Undamped oscillations.** The electrical oscillations whose amplitude remains constant with time are called *undamped oscillations*. Fig. 14.1 (*ii*) shows waveform of undamped electrical oscillations. Although the electrical system in which these oscillations are being generated has also losses, but now right amount of energy is being supplied to overcome the losses. Consequently, the amplitude of the generated wave remains constant. It should be emphasised that an oscillator is required to produce undamped electrical oscillations for utilising in various electronics equipment.

## 14.3 Oscillatory Circuit

*A circuit which produces electrical oscillations of any desired frequency is known as an* **oscillatory circuit** *or* **tank circuit.**

A simple oscillatory circuit consists of a capacitor (*C*) and inductance coil (*L*) in parallel as shown in Fig. 14.2. This electrical system can produce electrical oscillations of frequency determined by the values of *L* and *C*. To understand how this comes about, suppose the capacitor is charged from a d.c. source with a polarity as shown in Fig. 14.2 (*i*).

**(*i*)** In the position shown in Fig. 14.2 (*i*), the upper plate of capacitor has deficit of electrons and the lower plate has excess of electrons. Therefore, there is a voltage across the capacitor and the capacitor has electrostatic energy.

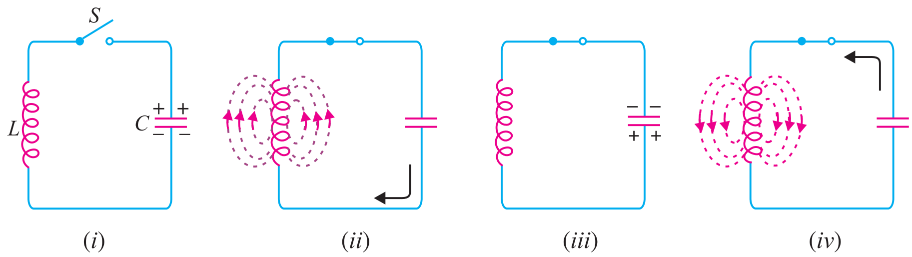



**Fig. 14.2**

**(*ii*)** When switch *S* is closed as shown in Fig. 14.2 (*ii*) , the capacitor will discharge through inductance and the electron flow will be in the direction indicated by the arrow. This current flow sets up magnetic field around the coil. Due to the inductive effect, the current builds up slowly towards a maximum value. The circuit current will be maximum when the capacitor is fully discharged. At this instant, electrostatic energy is zero but because electron motion is greatest (*i.e.* maximum current), the magnetic field energy around the coil is maximum. This is shown in Fig. 14.2 (*ii*). Obviously, the electrostatic energy across the capacitor is completely converted into magnetic field energy around the coil.

**(*iii*)** Once the capacitor is discharged, the magnetic field will begin to collapse and produce a counter e.m.f. According to Lenz's law, the counter e.m.f. will keep the current flowing in the same direction. The result is that the capacitor is now charged with opposite polarity, making upper plate of capacitor negative and lower plate positive as shown in Fig. 14.2 (*iii*).

**(*iv*)** After the collapsing field has recharged the capacitor, the capacitor now begins to discharge; current now flowing in the opposite direction. Fig. 14.2 (*iv*) shows capacitor fully discharged and maximum current flowing.

The sequence of charge and discharge results in alternating motion of electrons or an oscillating current. The energy is alternately stored in the electric field of the capacitor (*C*) and the magnetic field of the inductance coil (*L*). This interchange of energy between *L* and *C* is repeated over and again resulting in the production of oscillations.