SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB201 –ANALOG ELECTRONIC CIRCUITS

II Year B.E.ECE - III Semester

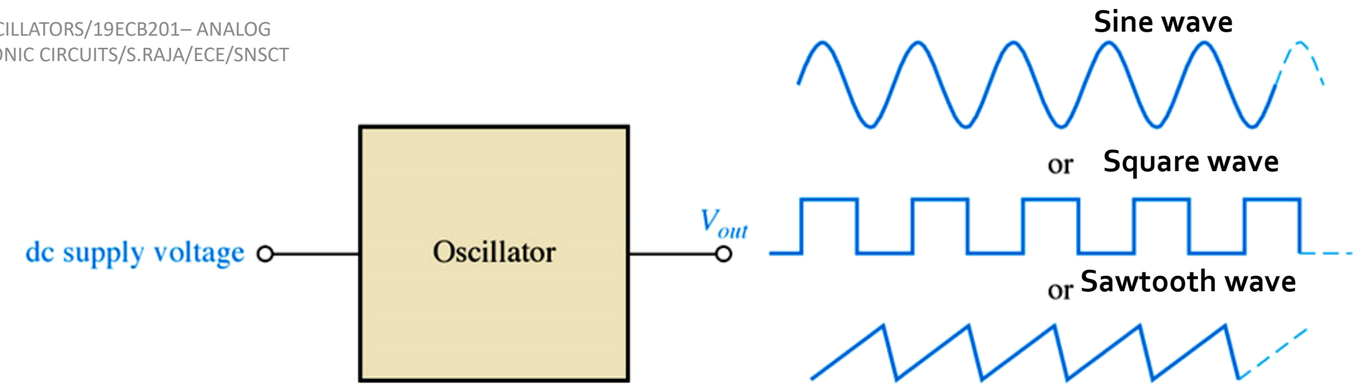
TOPIC– LC OSCILLATORS

OSCILLATOR (RECAP)

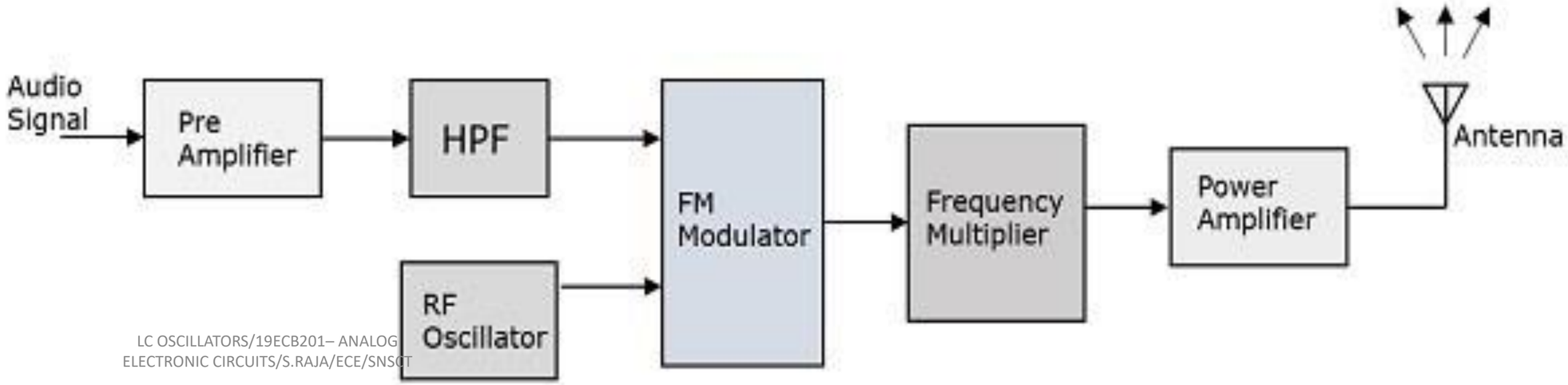
- Oscillators convert a DC input (the supply voltage) into an AC output (the waveform), which can have a wide range of different wave shapes and frequencies

To operate as an oscillator, it must have the following three characteristics.

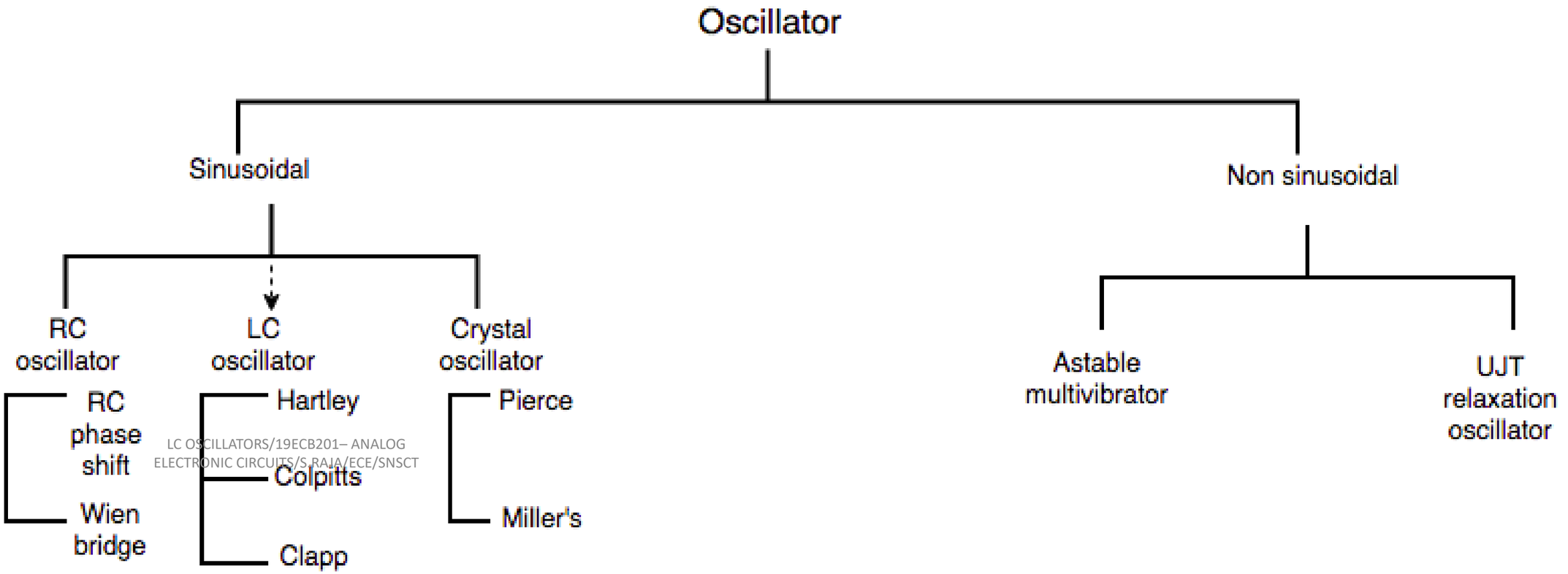
- Some form of Amplification
- Positive Feedback (regeneration)
- A Frequency determine feedback network



Application of Oscillators (FM Transmitter)

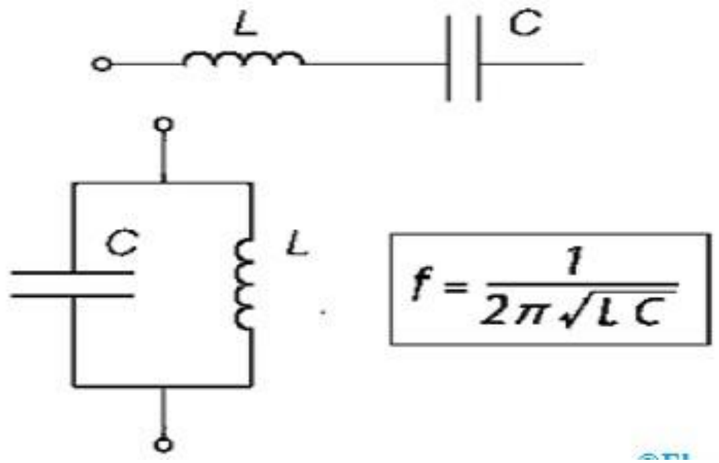


CLASSIFICATION OF OSCILLATORS



LC OSCILLATORS

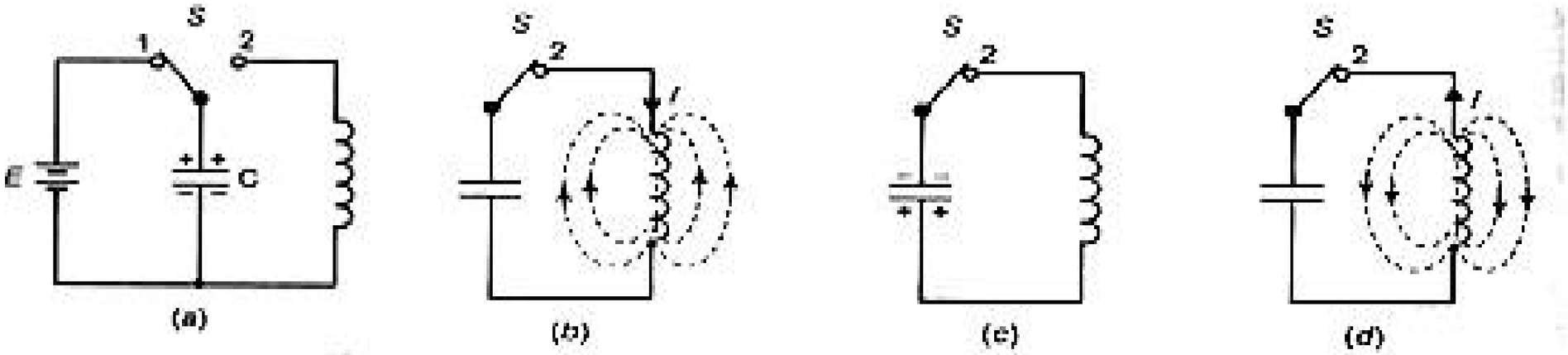
- The oscillators which use the elements L and C to produce the oscillations are called LC oscillators
- These oscillators are used for high frequency range from 200 kHz up to few GHz.



Why LC oscillators?

- Why LC oscillator is better than RC oscillator?
- LC oscillators are preferred at higher frequencies because of their high-Quality factor and a wider range of frequencies.
- LC oscillators offer greater stability, and produce sinusoidal waveforms with fewer harmonics.
- LC circuit is used for generating high frequency because as the frequency goes higher and higher, physical size of LC also becomes smaller.
- LC oscillators can be designed using OP-AMP and Transistors.

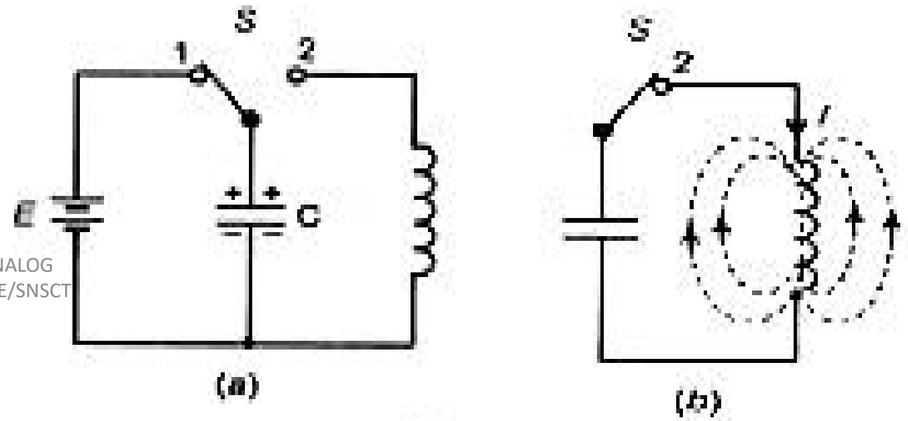
Tank circuit



- The capacitor stores energy in the form of an electrostatic field and which produces a potential (static voltage) across its plates, while the inductive coil stores its energy in the form of an electromagnetic field.

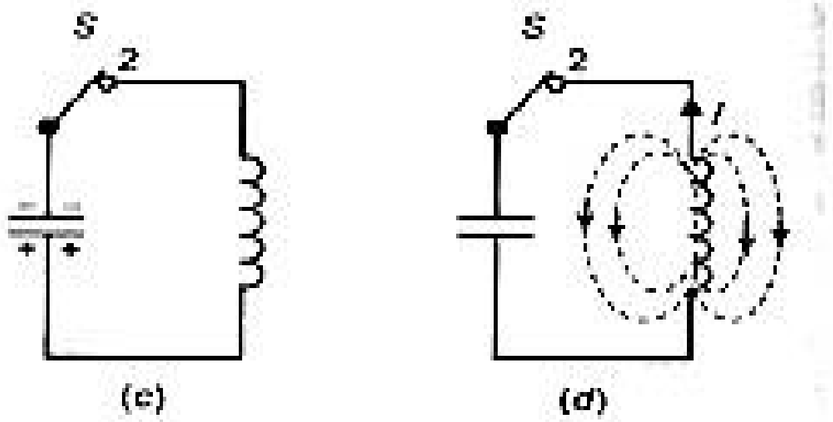
Tank circuit

- The capacitor is charged up to the DC supply voltage, V by putting the switch in position 1.
- When the capacitor is fully charged the switch changes to position 2.



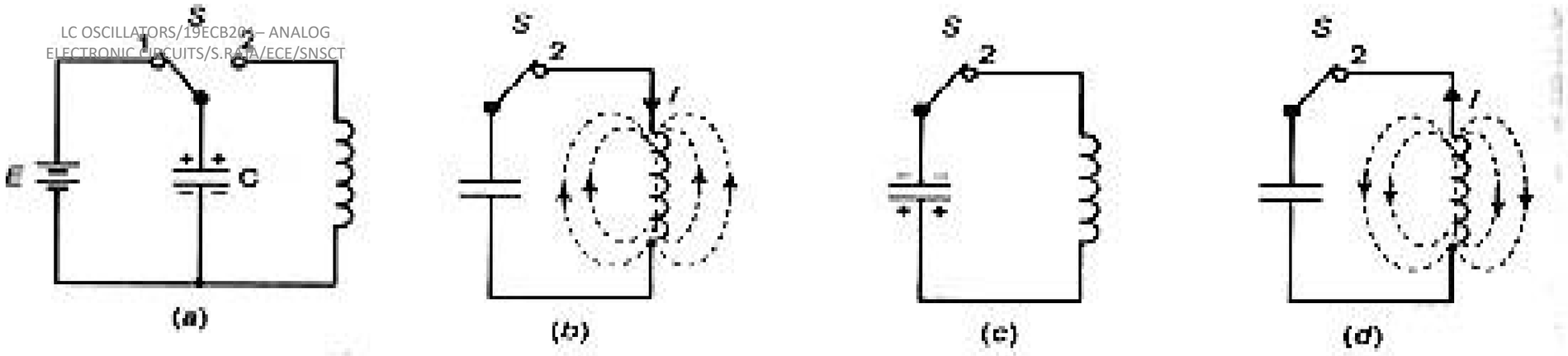
Tank circuit

- The charged capacitor is now connected in parallel across the inductive coil so the capacitor begins to discharge itself through the coil.
- The voltage across C starts falling as the current through the coil begins to rise. This rising current sets up an electromagnetic field around the coil which resists this flow of current.



Tank circuit

- When the capacitor, C is completely discharged the energy that was originally stored in the capacitor, C as an electrostatic filed is now stored in the inductive coil, L as an electromagnetic field around the coils windings.
- As there is now no external voltage in the circuit to maintain the current within the coil, it starts to fall as the electromagnetic field begins to collapse.



Tuned circuit

- A back emf is induced in the coil (e=-Ldi/dt) keeping the current flowing in the original direction.
- This current now charges up the capacitor, c with the opposite polarity to its original charge.
- Capacitor continues to charge up until the current reduces to zero and the electromagnetic field of the coil has collapsed completely.
- The capacitor now starts to discharge again back through the coil and the whole process so repeated.
- The polarity of the voltage changes as the energy is passed back and forth between the capacitor and inductor producing an AC type sinusoidal voltage and current waveform.

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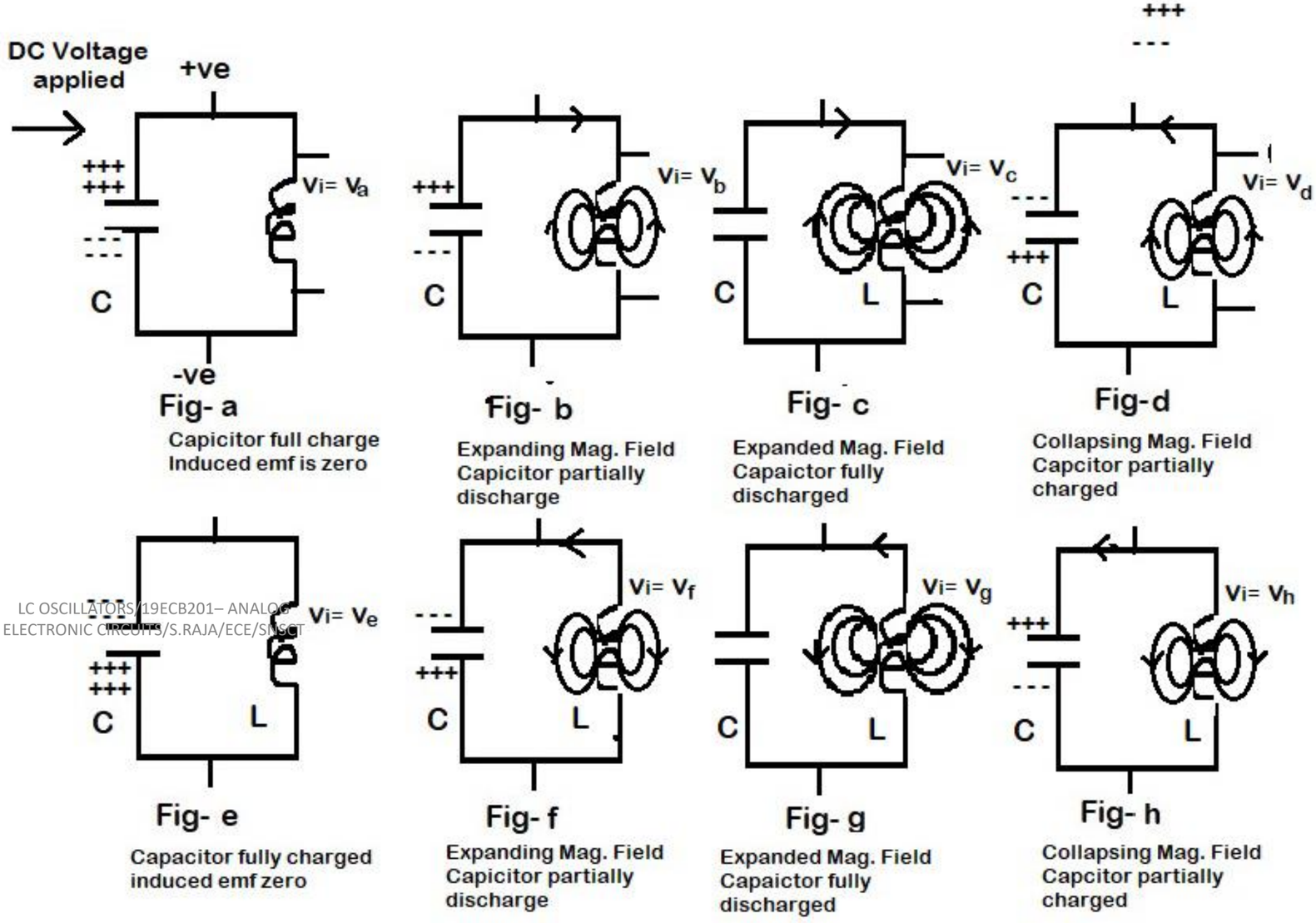
Tank circuit working



Activity

WHO AM I?

Amplifier

Tuned Amplifier

Oscillator

Differential amplifier

Feedback amplifier

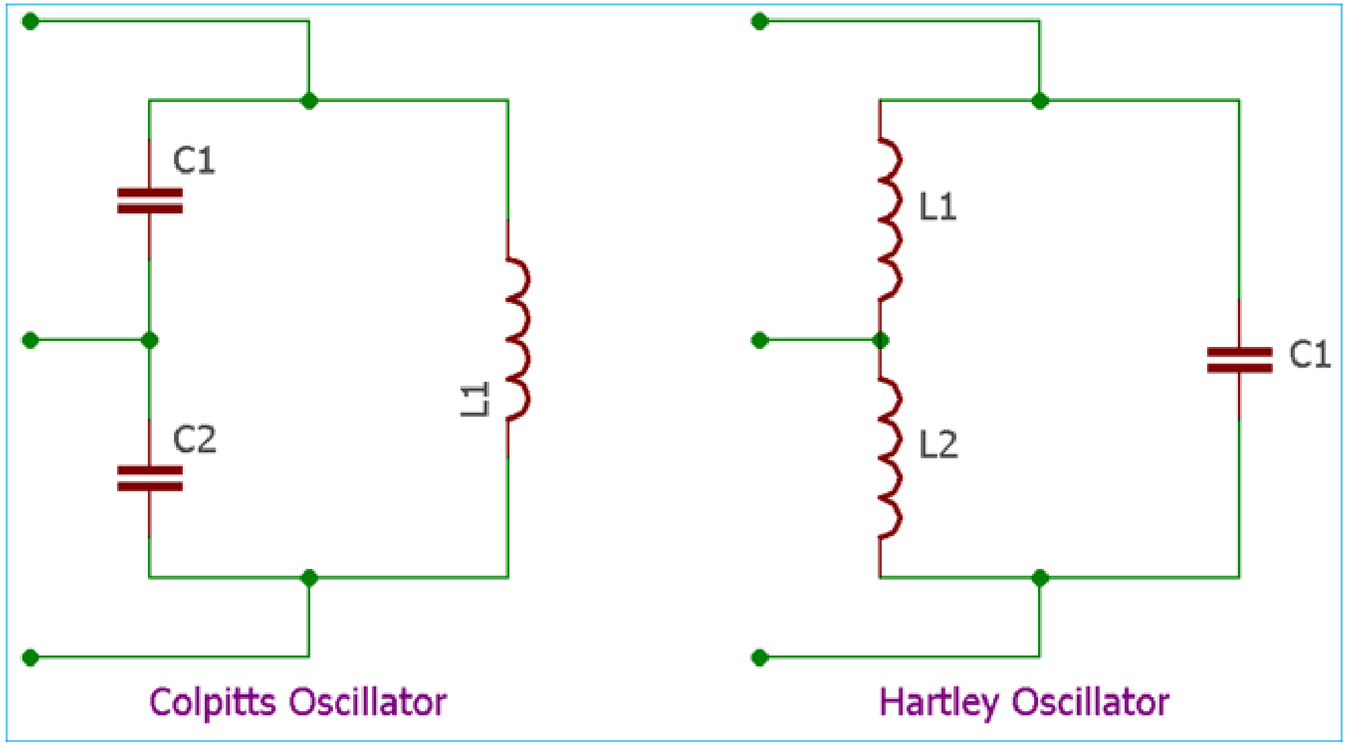
LC Oscillator

Stagger tuned Amp

TYPES OF LC OSCILLATORS

LC oscillators

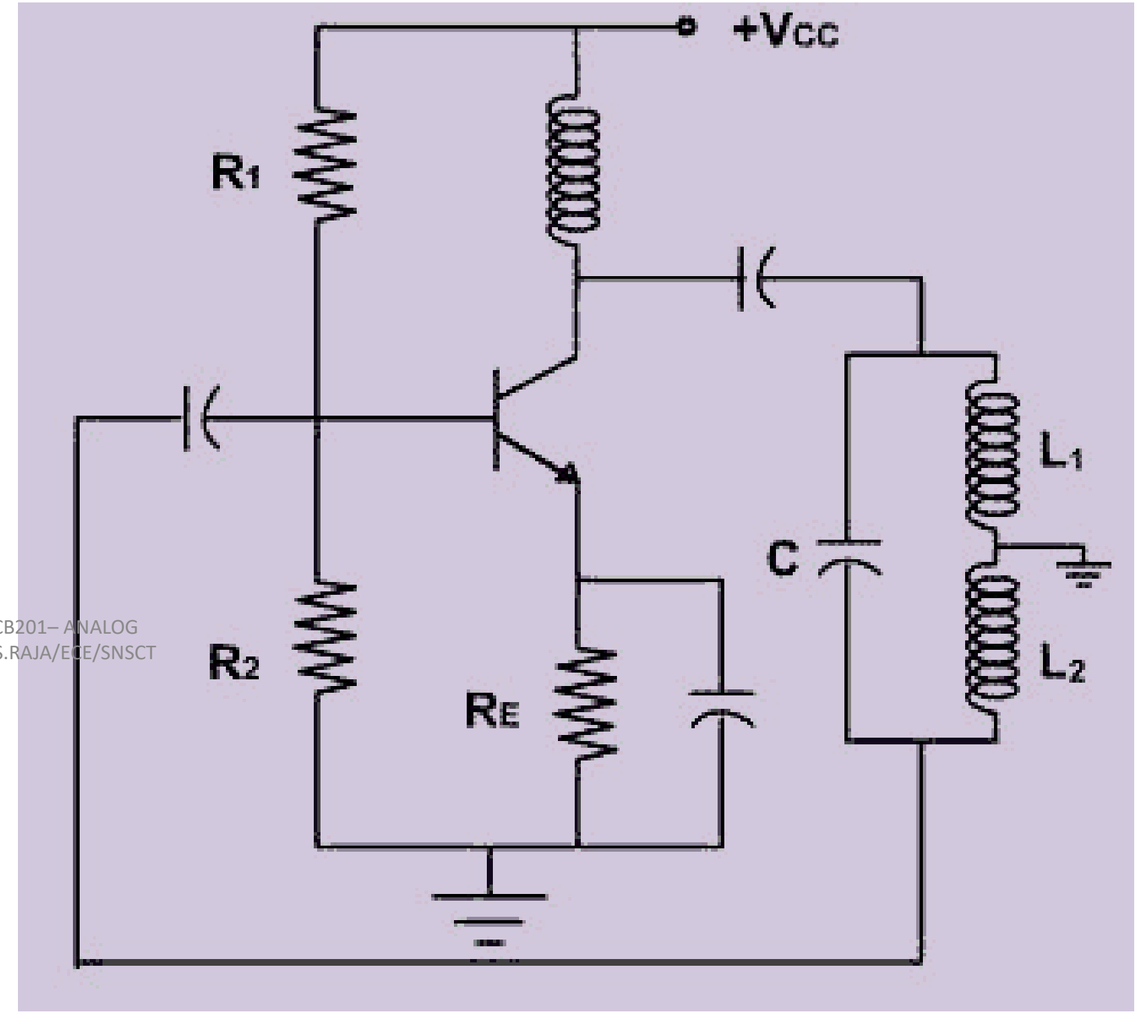
- Hartley
- Colpitts
- Crystal



Hartley oscillator

- Hartley Oscillator is a device that generates oscillatory output (sinusoidal).
- It uses two inductive reactance and one capacitive reactance in its feedback network.
- It consists of an amplifier linked to an oscillatory circuit, also called LC circuit or tank circuit. The function of tank circuit is to tune a certain frequency.
- However they can also be designed to produce oscillations in the low audio frequency range. But for the low-frequency operation, the inductors used will be very large in value, i.e of milli Henrie range and hence very large in physical size.

Hartley oscillator



Working of Hartley oscillator

- When the collector supply is given, a transient current is produced in the oscillatory or tank circuit. The oscillatory current in the tank circuit produces a.c. voltage across L1.

- As the CE configured transistor provides 180^o phase shift, another 180^o phase shift is provided by the tank circuit, which makes 360^o phase shift between the input and output voltages.

- This makes the feedback positive which is essential for the condition of oscillations. When the loop gain $|\beta A|$ of the amplifier is greater than one, oscillations are sustained in the circuit.

Applications

- The Hartley oscillator is to produce a sine wave with the desired frequency
- Hartley oscillators are mainly used as radio receivers. Also note that due to its wide range of frequencies, it is the most popular oscillator
- The Hartley oscillator is Suitable for oscillations in RF (Radio-Frequency) range, up to 30MHZ

LC Oscillators Summary

- For oscillations to exist an oscillator circuit must contain a reactive (frequency dependant) component either an “Inductor”, (L) or a “Capacitor”, (C) as well as a DC power source.
- In a simple inductor-capacitor, LC circuit, oscillations become damped over time due to component and circuit losses.
- Voltage amplification is required to overcome these circuit losses and provide positive gain.
- The overall gain of the amplifier must be greater than one, unity.
- Oscillations can be maintained by feeding back some of the output voltage to the
- tuned circuit that is of the correct amplitude and in-phase, (0^o).

ASSESSMENT

1. An inductance of 200mH and a capacitor of 10pF are connected together in parallel to create an LC oscillator tank circuit. Calculate the frequency of oscillation

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1. An inductance of 200mH and a capacitor of 10pF are connected together in parallel to create an LC oscillator tank circuit.

   Calculate the frequency of oscillation

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{200\,\text{mH} \times 10\,\text{pF}}} = 112.5\ \text{kHz}$$

THANK YOU