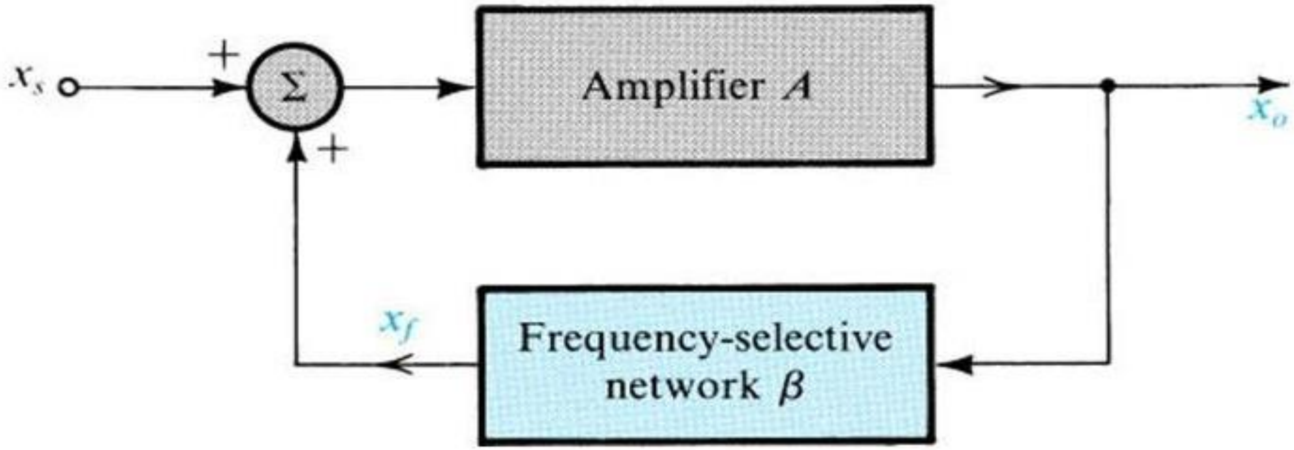
OSCILLATORS

OSCILLATORS

- Employs positive feedback loop consisting of an amplifier and an RC or LC frequency selective circuit.

- Amplitude of the generated sine wave is limited by using non linear mechanism.

OSCILLATOR FEEDBACK LOOP



The basic structure of a sinusoidal oscillator.

- A **positive-feedback loop** is formed by an amplifier *A* and a frequency-selective network β.
- In an actual oscillator circuit, no input signal will be present; here an input signal x_s is employed to help explain the principle of operation.

BASIC PRINCIPLES OF SINUSOIDAL OSCILLATOR

- Nonlinear amplitude control
  - To ensure that oscillations will start, the Aβ is slightly greater than unity.
  - As the power supply is turned on, oscillation will grown in amplitude.
  - When the amplitude reaches the desired level, the nonlinear network comes into action and cause the Aβ to exactly unity.

OSCILLATOR FEEDBACK LOOP

Loop gain $L(S) = A(S).\beta(S)$

$$A_f(s) = \frac{A(s)}{1 - A(s).\beta(s)} = \frac{A(s)}{1 - L(s)}$$

- If at frequency ω_0 the loop gain is equal to unity; A_f will be infinite.
- That is at that frequency circuit will have a finite output for zero input signal.

BARKHAUSEN CRITERIA

- At ω_0, the phase of the loop gain should be zero and the magnitude of the loop gain should be unity.
- That is for the circuit to oscillate at one frequency the oscillation criterion should be satisfied at ω_0.

$$x_f = \beta x_0$$
$$A x_f = x_0$$
$$A\beta x_0 = x_0$$
$$A\beta = 1$$

BARKHAUSEN CRITERIA

- For the circuit to produce sustained oscillations at a frequency ω_0 the characteristic equation has to have a roots at $s = \pm j\omega$.

Thus $1 - A(s).\beta(s)$ should have a factor of the form of

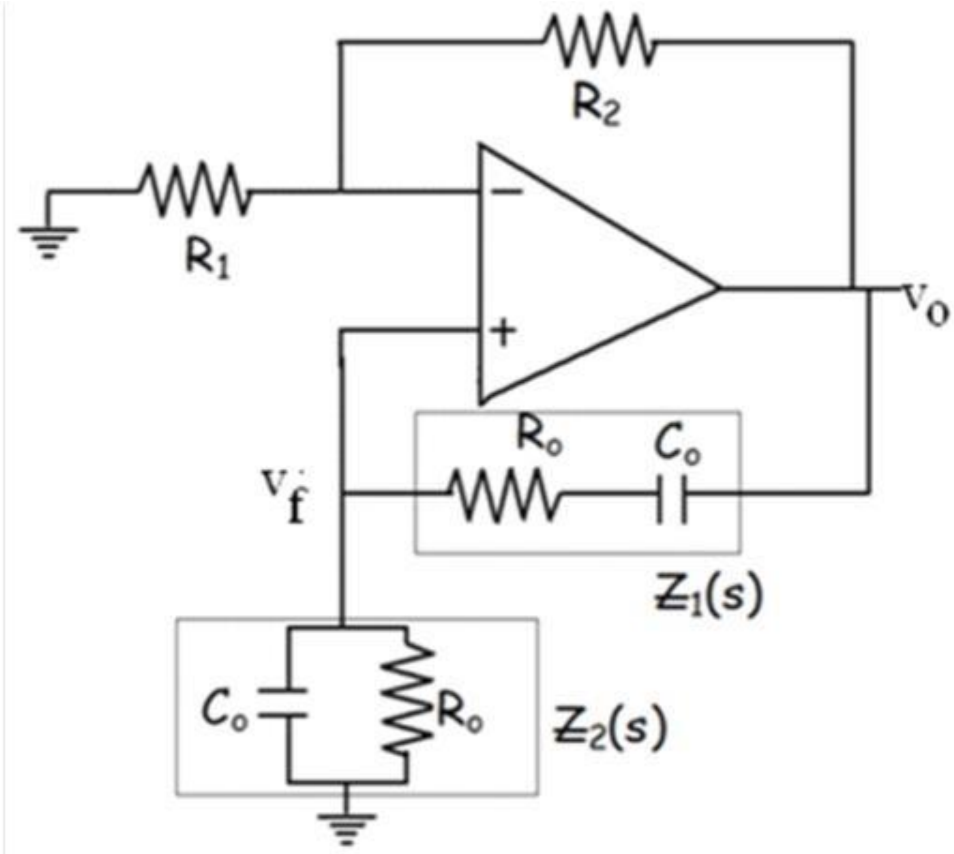
$$s^2 + \omega_0^2$$

OSCILLATOR CIRCUITS

- Op Amp-RC Oscillator Circuits
  - ➢ The Wien-Bridge Oscillator
  - ➢ The phase-Shift Oscillator
- LC-Tuned Oscillator
  - ➢ Colpitts oscillator
  - ➢ Hareley oscillator
- Crystal Oscillator

RC OSCILLATOR CIRCUIT

- The Wein Bridge Oscillator

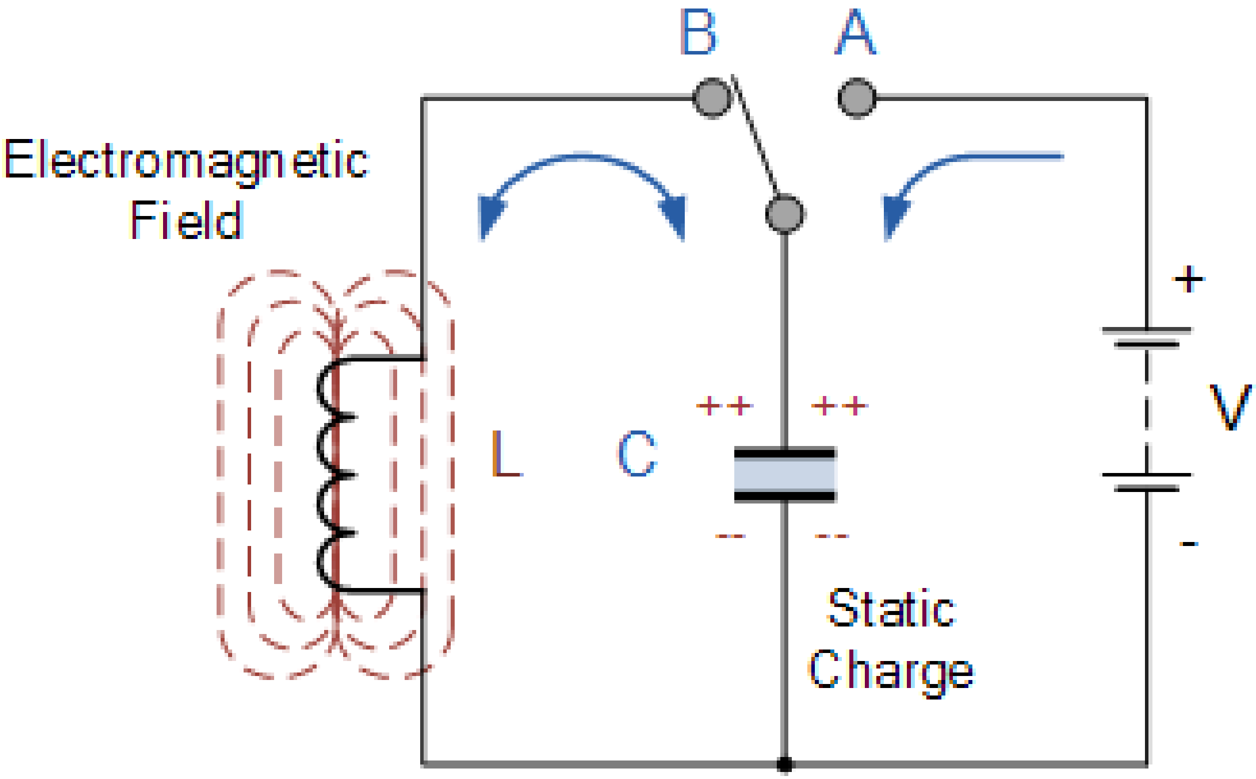


LC OSCILLATORS

- Resonance – A condition in a circuit containing inductance and capacitance where the inductive reactance is equal to the capacitive reactance

- Resonant circuit is also called as LC tank circuit

BASIC LC OSCILLATOR CIRCUIT



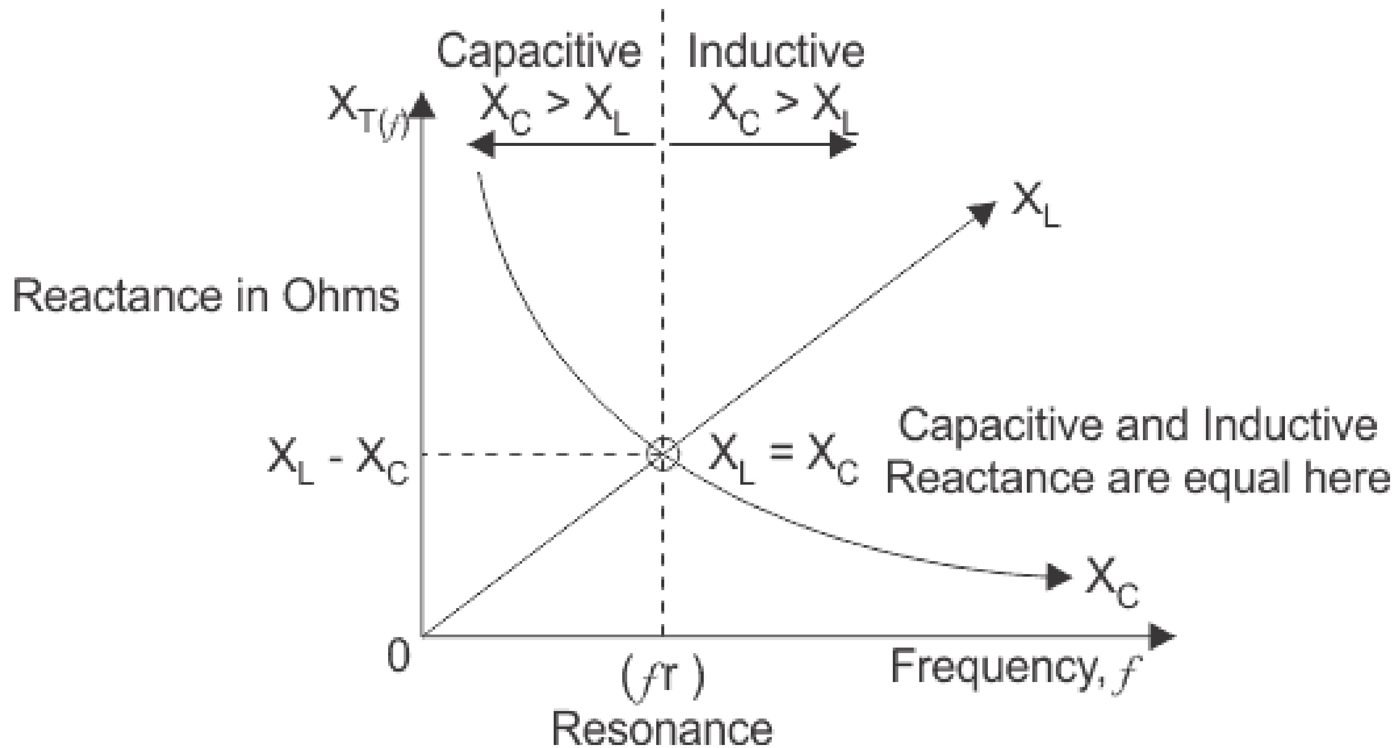
BASIC LC OSCILLATOR CIRCUIT

- The capacitor stores energy in the form of an electrostatic field and inductive coil stores its energy in the form of electromagnetic field.
- The capacitor is charged upto the DC supply voltage, V by putting the switch position A. When capacitor is fully charged the switch changes to position B.
- Capacitor begins to discharge itself through coil.
- The rising current sets up an electromagnetic field around the coil which resists this flow of current.

BASIC LC OSCILLATOR CIRCUIT

- When capacitor C is completely discharged the energy stored in the capacitor is now stored in the inductive coil as an electromagnetic field around the coil winding.
- Then it starts to fall as the electromagnetic field begins to collapse.
- Back emf $e = -L\frac{di}{dt}$ keeping the current flowing in the original direction.
- This current charges up capacitor with opposite polarity.
- The polarity of the voltage changes as the energy is passed back and forth between the capacitor and the inductor.
- If there is no loss this will continue indefinitely.

REACTANCE VS. REACTANCE



$$X_L = 2\pi f L$$

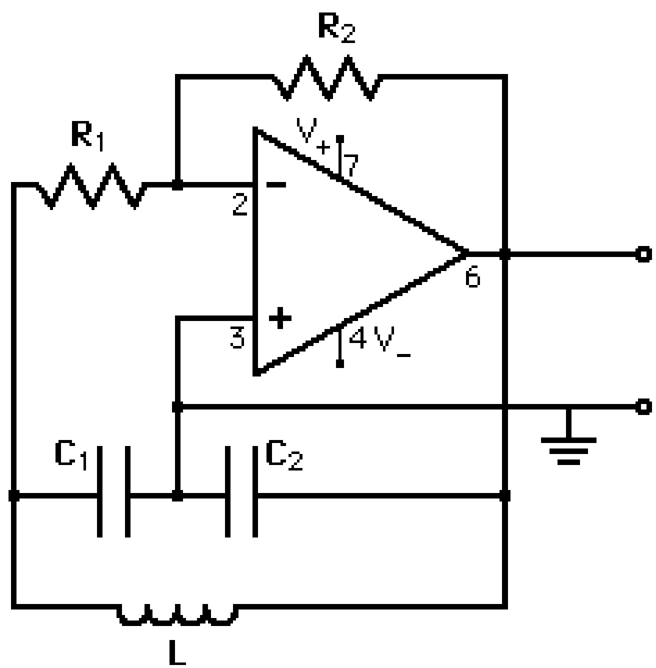
$$X_C = \frac{1}{2\pi f C}$$

At Resonance $X_L = X_C$

Therefore $2\pi f L = \frac{1}{2\pi f}$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

THE COLPITTS OSCILLATOR

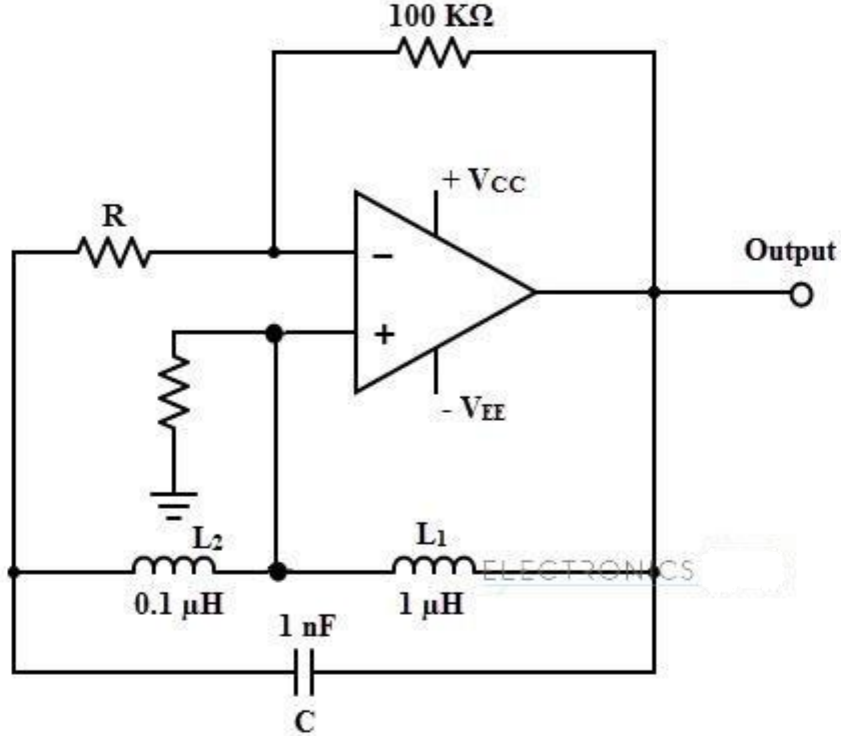


$$f = \frac{1}{2\pi\sqrt{LC}}$$

Where C is the equivalent value if the capacitance and equal to $\frac{C_1 C_2}{C_1 + C_2}$

$$f = \frac{1}{2\pi\sqrt{L\left(\frac{C_1 C_2}{C_1 + C_2}\right)}}$$

THE HARTELY OSCILLATOR



$$f_r = \frac{1}{2\pi\sqrt{L_T C}} = \frac{1}{2\pi\sqrt{(L_1 + L_2)C}}$$

CRYSTAL OSCILLATORS

- Frequency stability is affected by variation in temperature, variations in the load and changes in dc power supply.
- Crystal Oscillator provides frequency stability under these varying conditions.
- The oscillator frequency is essentially determined by the crystal and not by the rest of the circuit.

CRYSTAL OSCILLATORS