OSCILLATORS

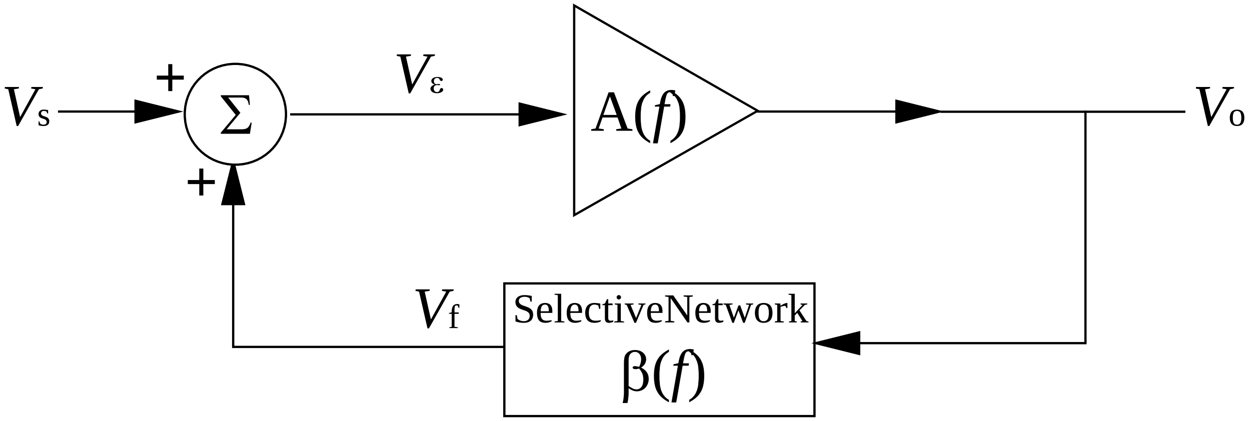
OSCILLATORS

Oscillation: an effect that repeatedly and regularly fluctuates about the mean value

Oscillator: circuit that produces oscillation

Characteristics: wave-shape, frequency, amplitude, distortion, stability

BASIC LINEAR OSCILLATOR



$$V_o = AV_\varepsilon = A(V_s + V_f) \quad \text{and} \quad V_f = \beta V_o$$

$$\Rightarrow \frac{V_o}{V_s} = \frac{A}{1 - A\beta}$$

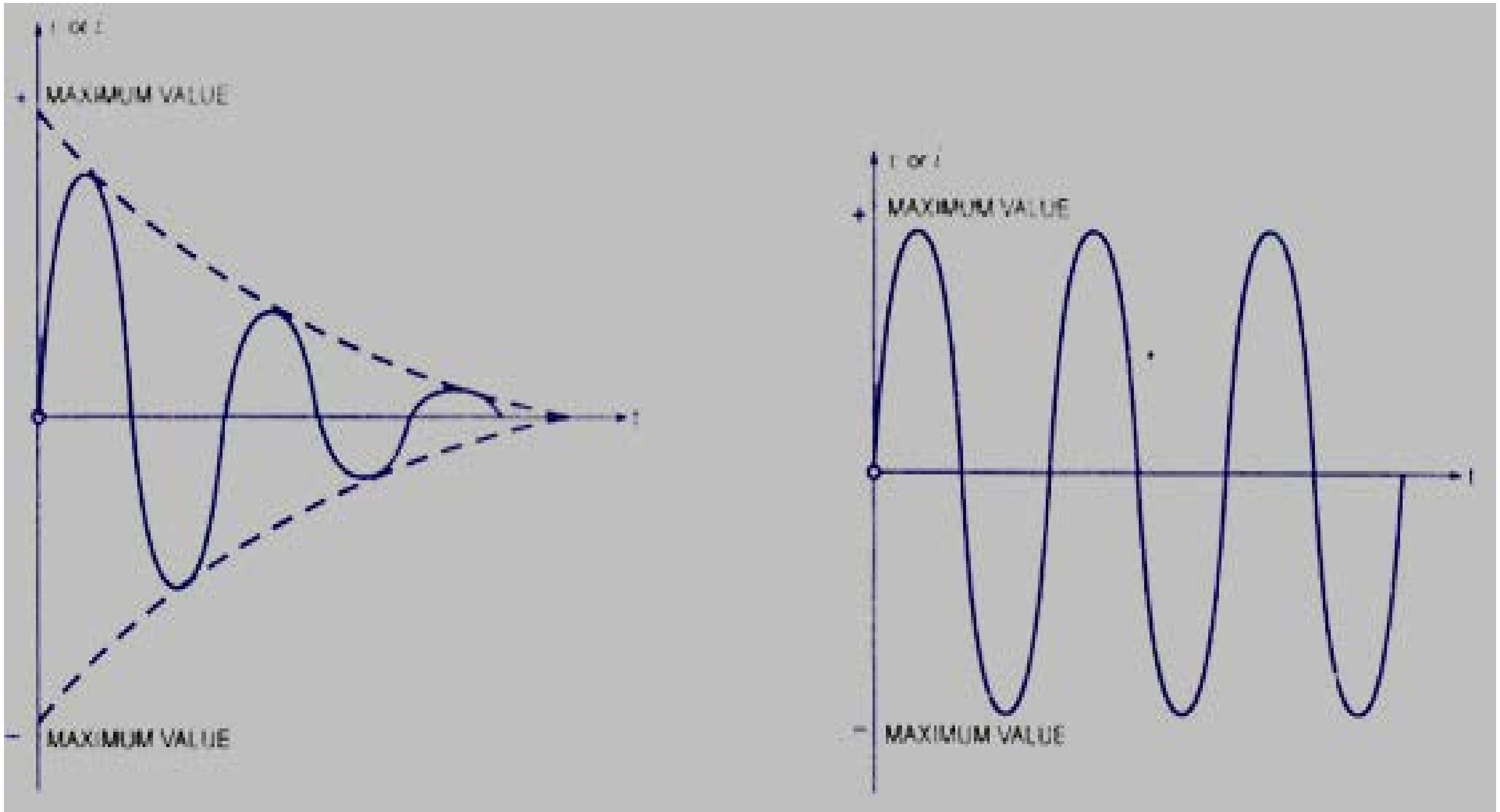
If $V_s = 0$, the only way that V_o can be nonzero is that loop gain $A\beta=1$ which implies that

$$|A\beta| = 1$$

$$\angle A\beta = 0$$

(Barkhausen Criterion)

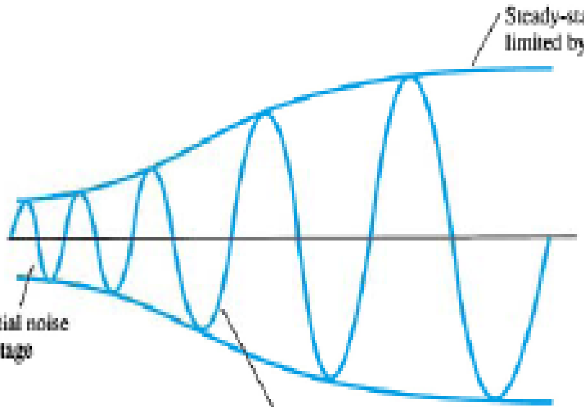
TYPES OF OSCILLATIONS



(a) *Damped Oscillations*

(b) *Undamped or Sustained Oscillations*

Oscillator Operation



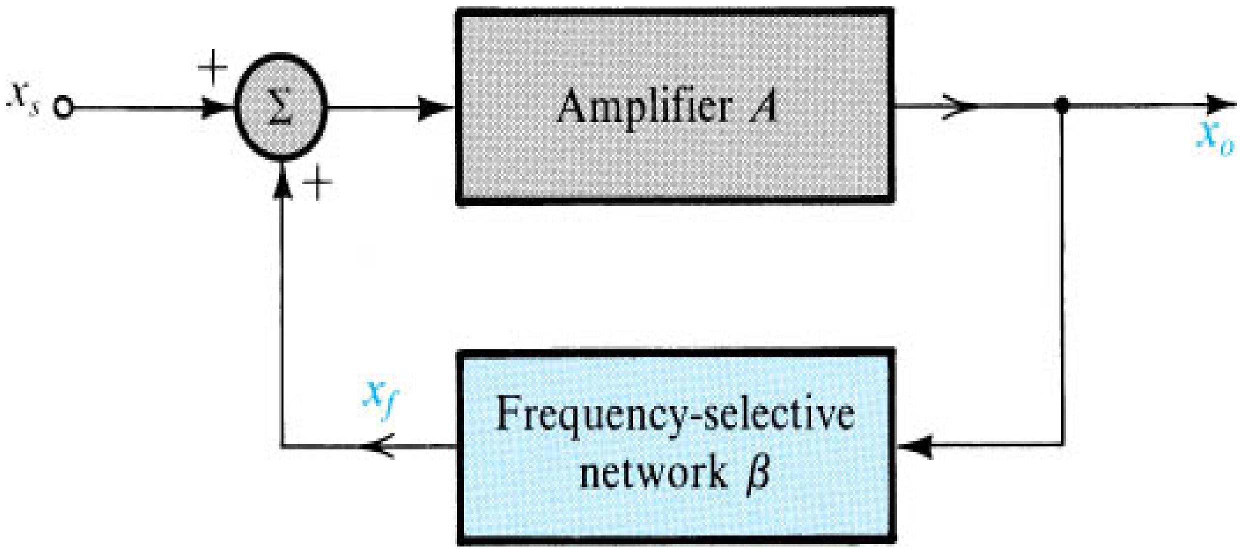
The feedback signal must be positive.

If the feedback signal is not positive or the gain is less than one, the oscillations dampens out.

The overall gain must equal one (unity gain).

If the overall gain is greater than one, the oscillator eventually saturates.

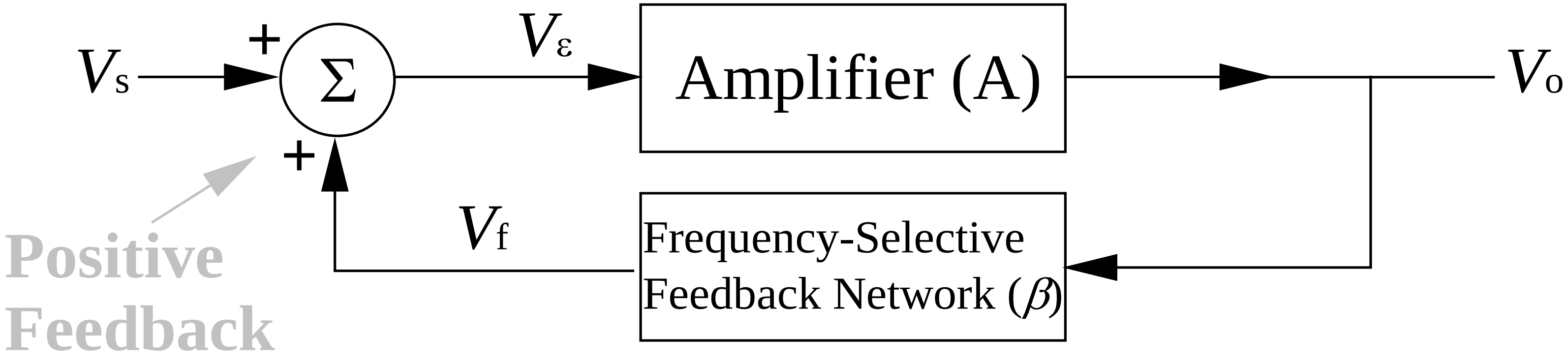
SIGNAL GENERATORS /OSCILLATORS



- A positive-feedback loop is formed by an amplifier and a frequency-selective network

- In an actual oscillator circuit, no input signal will be present

INTEGRANT OF LINEAR OSCILLATORS



For sinusoidal input is connected
"Linear" because the output is approximately sinusoidal

<u>A linear oscillator contains:</u>
- a frequency selection feedback network
- an amplifier to maintain the loop gain at **unity**

TYPES OF OSCILLATORS

1. Hartley Oscillator
2. Colpitt's oscillator
3. Wien Bridge Oscillators
4. RC Phase-Shift Oscillators
5. Crystal Oscillator

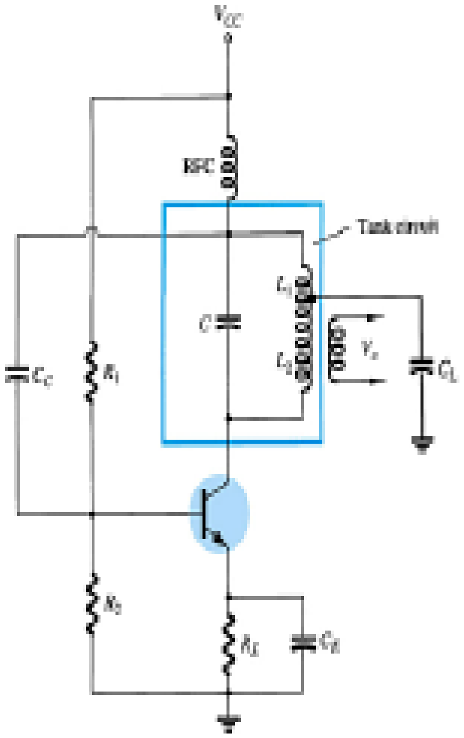
Hartley Oscillator Circuit

The frequency of oscillation is determined by:

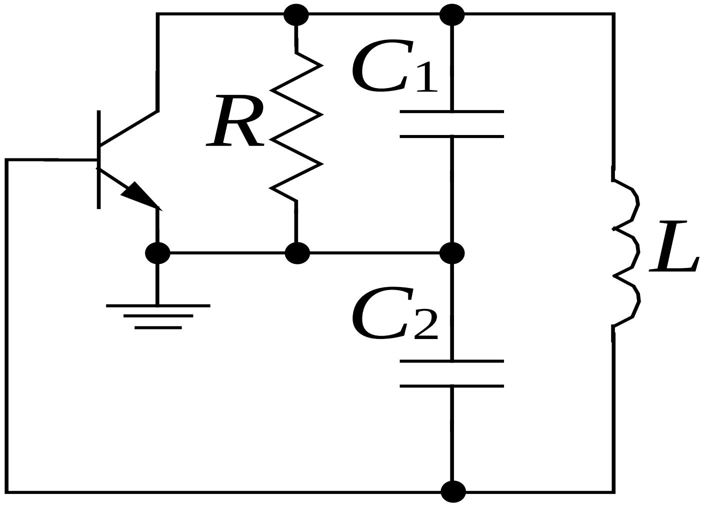
$$f_o = \frac{1}{2\pi\sqrt{L_{eq}C}}$$

where:

$$L_{eq} = L_1 + L_2 + 2M$$



COLPITTS OSCILLATOR



In the equivalent circuit, it is assumed that:

- Linear small signal model of transistor is used
- The transistor capacitances are neglected
- Input resistance of the transistor is large enough

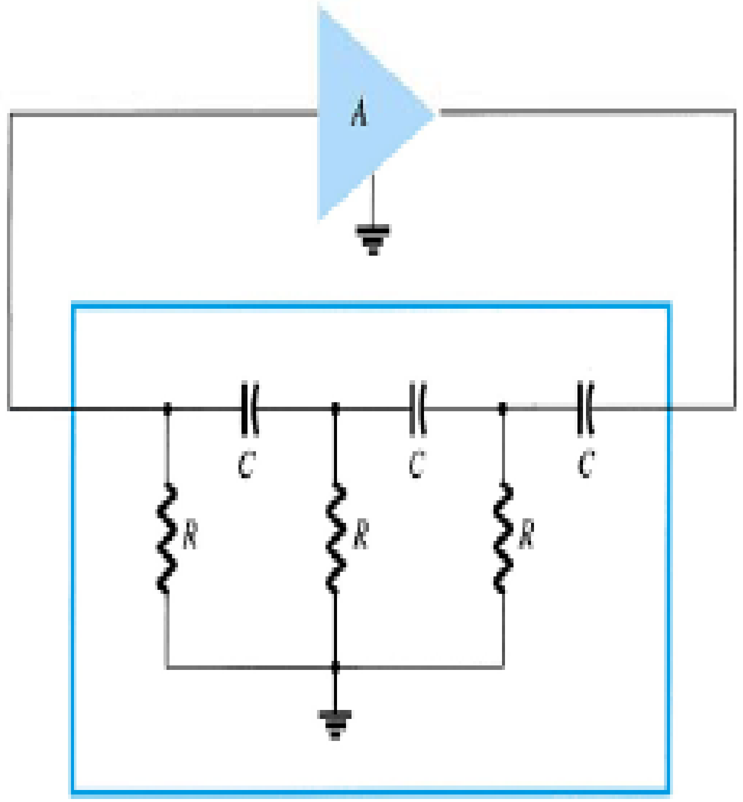
Phase-Shift Oscillator

The amplifier must supply enough gain to compensate for losses. The overall gain must be unity.

The RC networks provide the necessary phase shift for a positive feedback.

The values of the RC components also determine the frequency of oscillation:

$$f = \frac{1}{2\pi RC\sqrt{6}}$$



Feedback network

Crystal Oscillators

The crystal appears as a resonant circuit.

The crystal has two resonant frequencies:

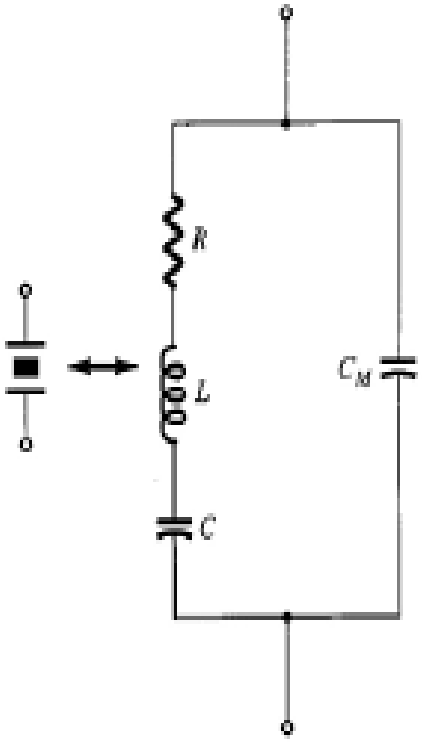
Series resonant condition

- RLC determine the resonant frequency
- The crystal has a low impedance

Parallel resonant condition

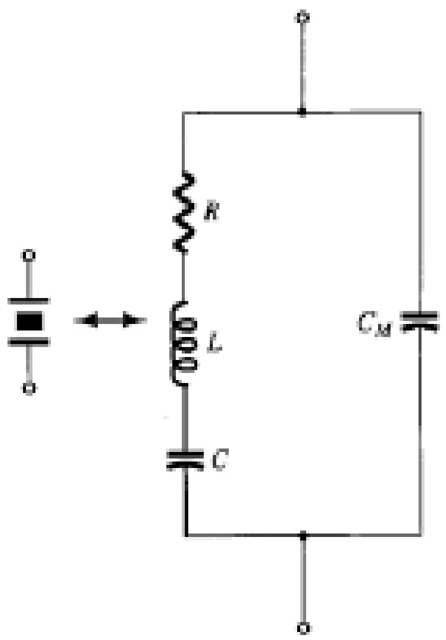
- RL and C_M determine the resonant frequency
- The crystal has a high impedance

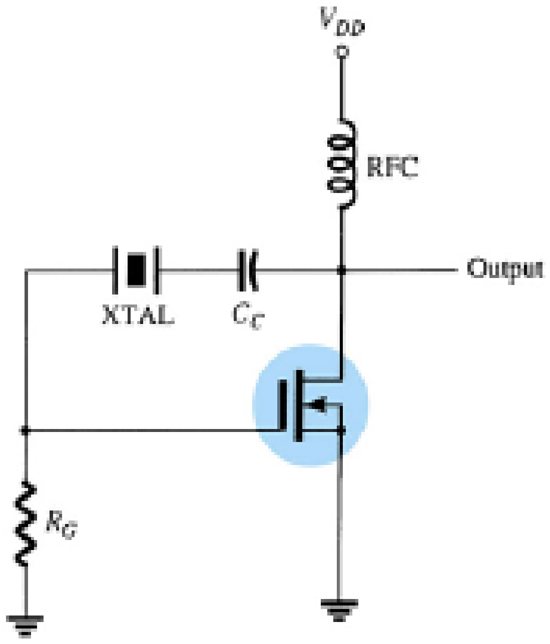
The series and parallel resonant frequencies are very close, within 1% of each other.



Series Resonant Crystal Oscillator

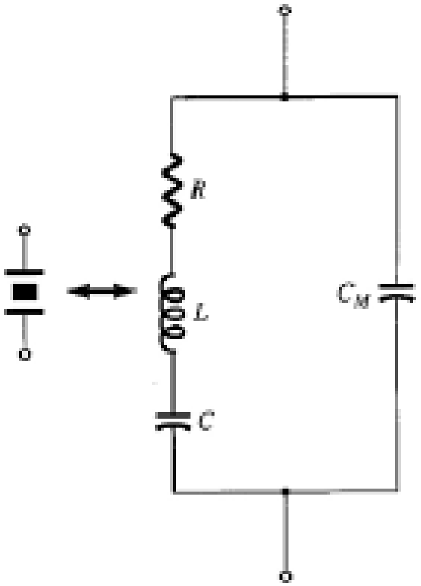
- RLC determine the resonant frequency
- The crystal has a low impedance

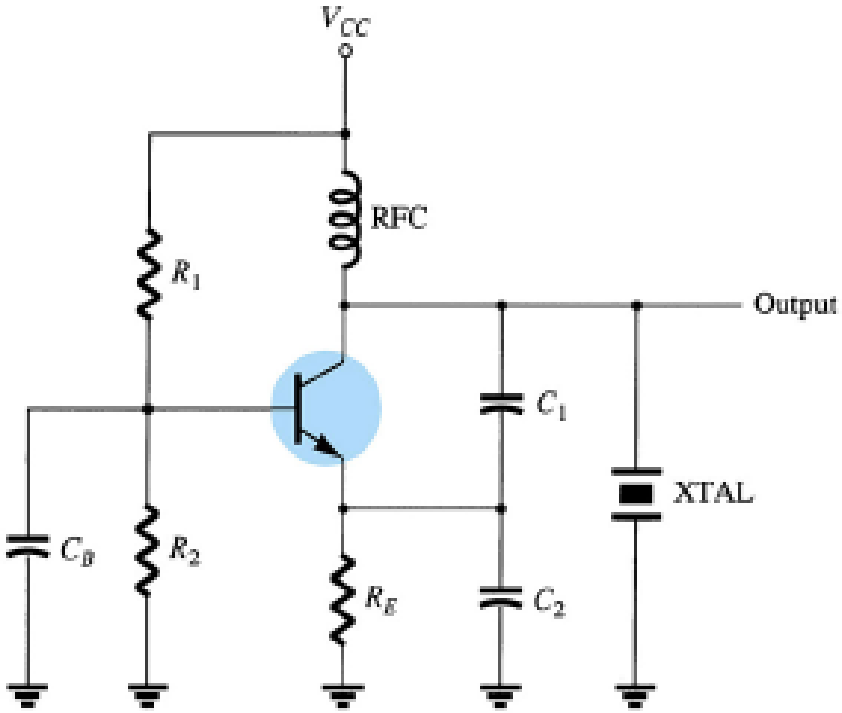




Parallel Resonant Crystal Oscillator

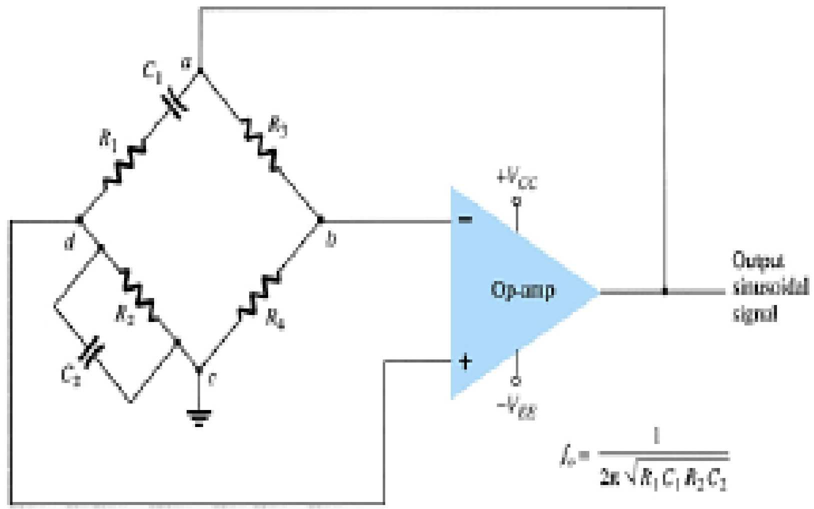
- R_L and C_M determine the resonant frequency
- The crystal has a high impedance





Wien Bridge Oscillator

The amplifier must supply enough gain to compensate for losses. The overall gain must be unity.



- The feedback resistors are R_3 and R_4.
- The phase-shift components are R_1, C_1 and R_2, C_2.

APPLICATION OF OSCILLATORS

- Oscillators are used to generate signals, e.g.
  - Used as a local oscillator to transform the RF signals to IF signals in a receiver;
  - Used to generate RF carrier in a transmitter
  - Used to generate clocks in digital systems;
  - Used as sweep circuits in TV sets and CRO.