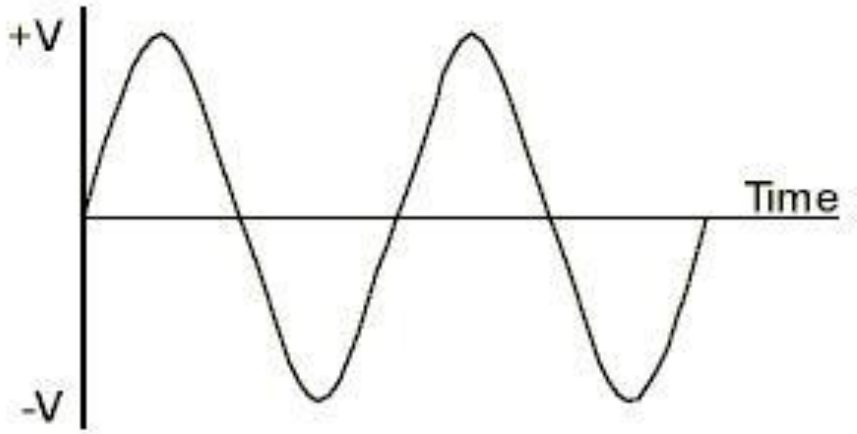
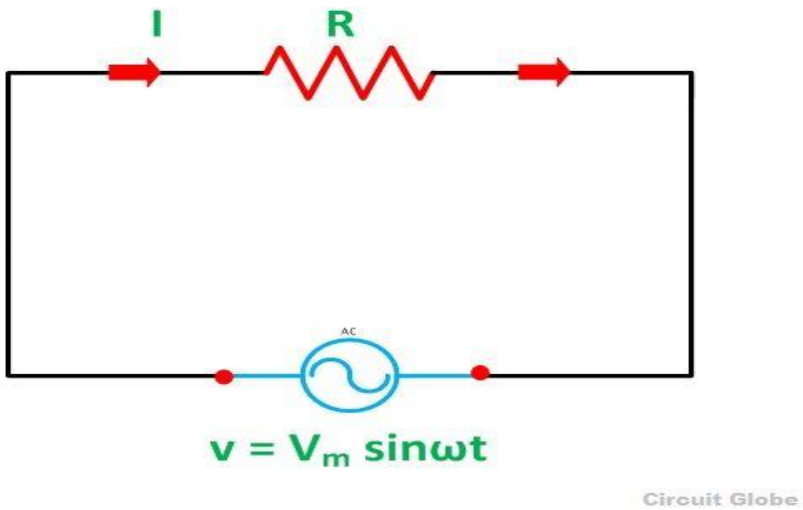
Unit-II: Alternating Currents & Filters

Alternating currents: Expression for the RMS value of voltage and currents, j operator, principles of superposition and phasor analysis. Response of LR, CR and LCR circuit to sinusoidal voltages using j operators. Series and parallel resonance circuits – expression for the 'Q' factor, bandwidth – expression for the power.

Filters: High and low pass filters using CR and LR circuits, frequency response curves, cutoff frequency, qualitative study of band pass filters. Problems.

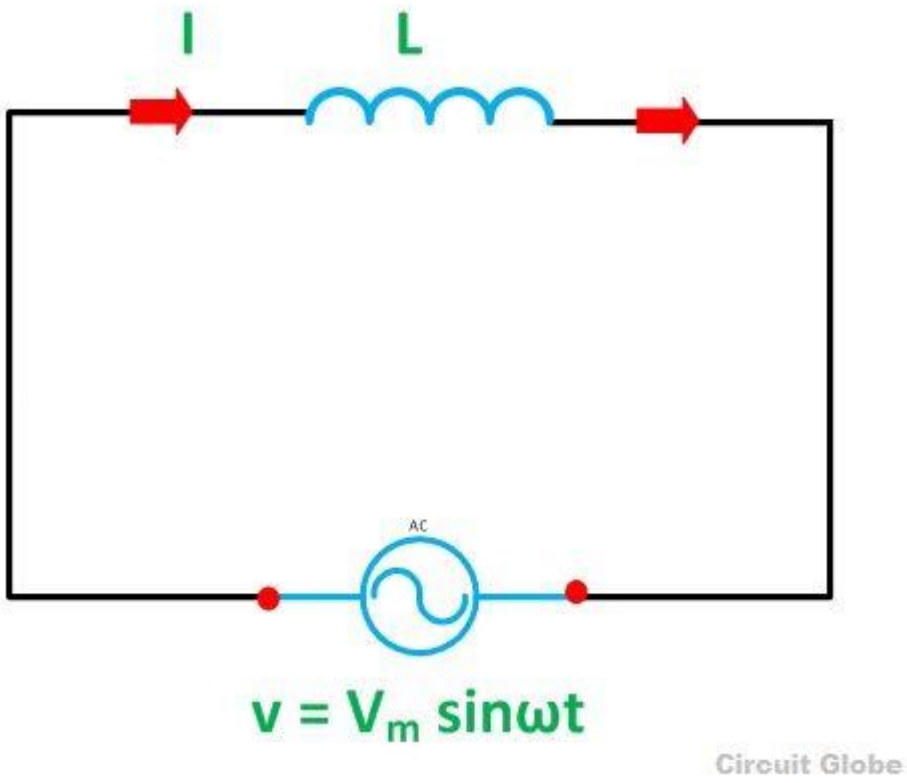


AC Circuit with pure Resistance-



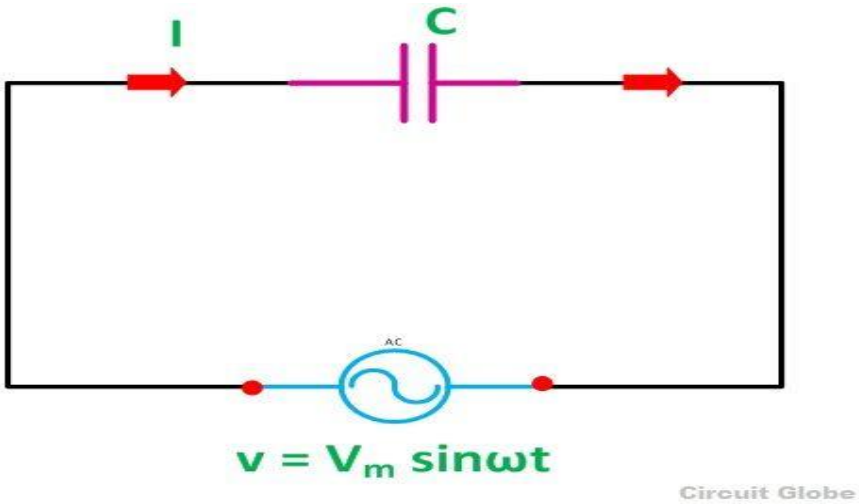
Current and voltage are in phase.

AC Circuit consisting of a pure inductance-



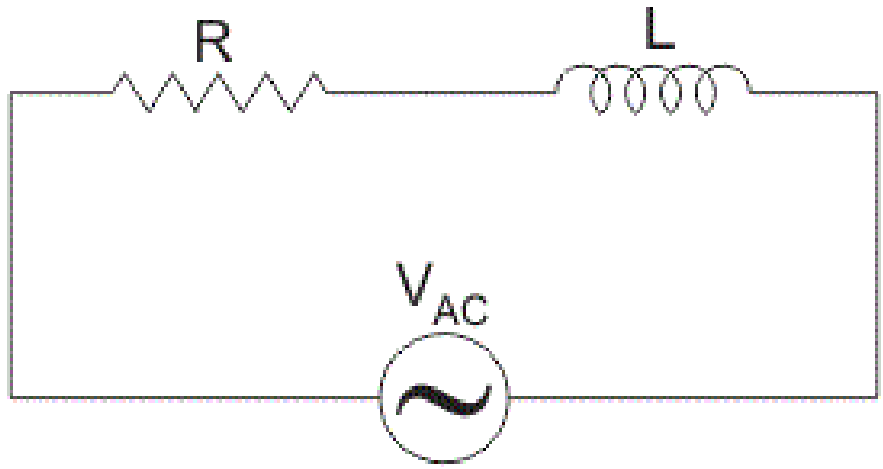
Current lags the voltage by 90º.

AC Circuit consisting of a pure Capacitance-



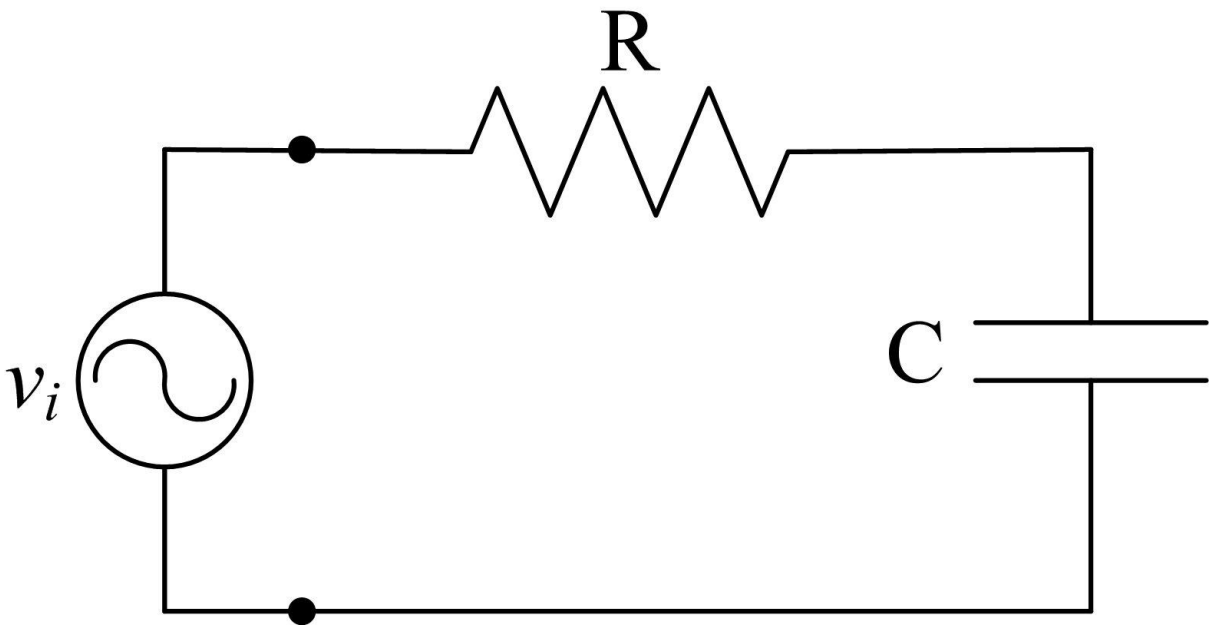
Current leads the voltage by 90º.

LR Circuit-



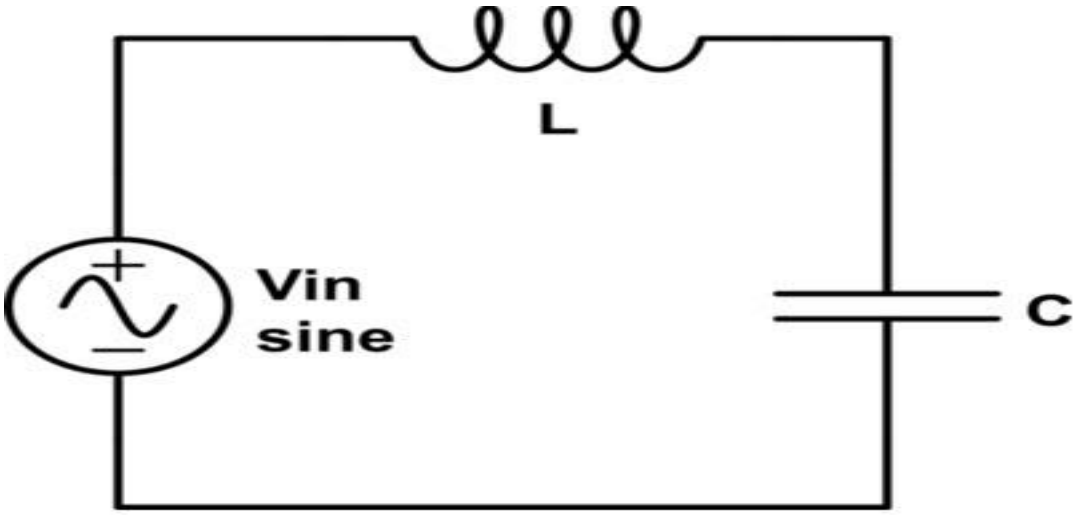
The current lags behind the voltage by a phase angle of Φ

CR Circuit-



The current leads the voltage by a phase angle of Φ

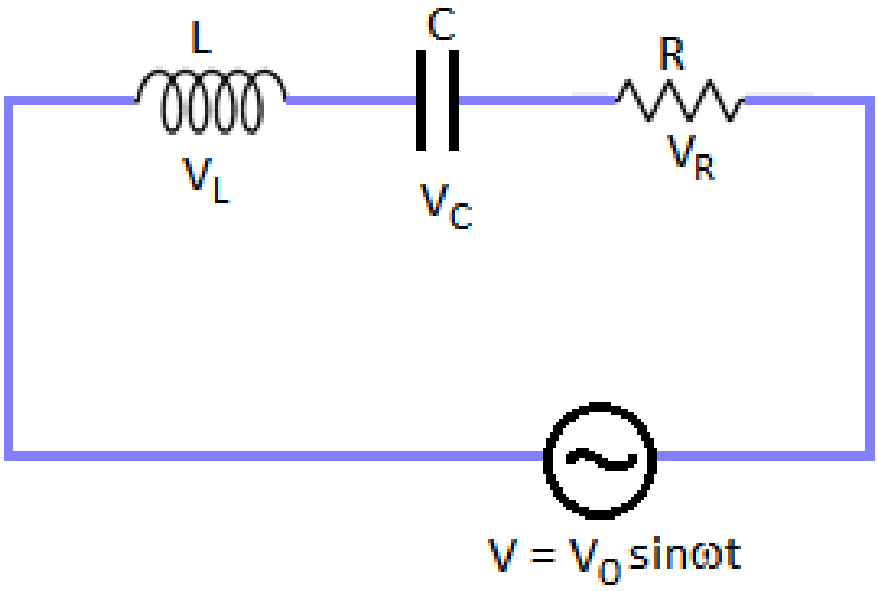
LC Circuit-

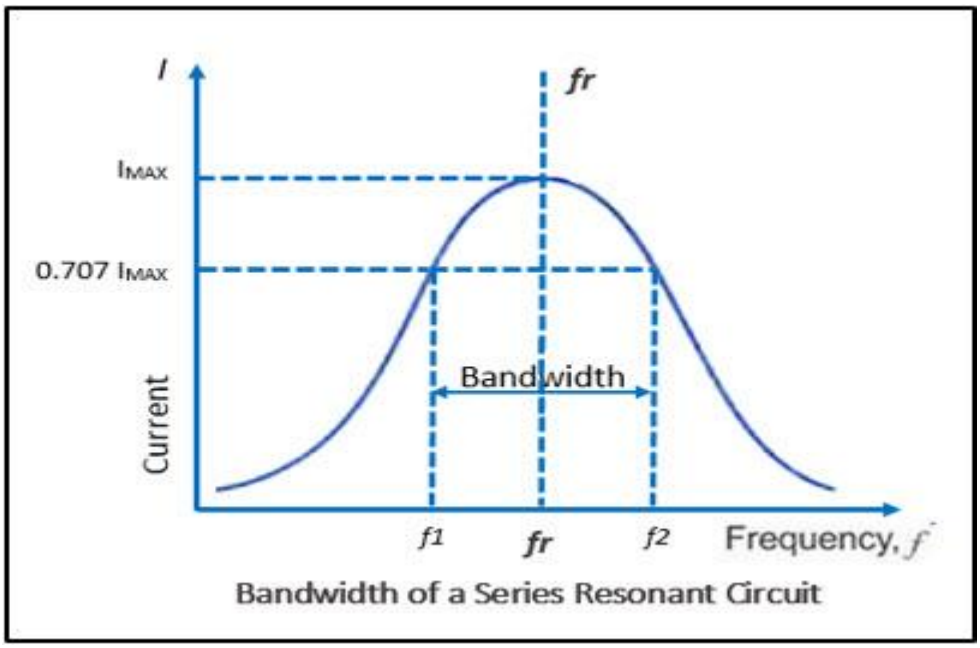


No question of phase angle as real part does not exist.

Series LCR Circuit-

(Voltage Magnification)





Bandwidth of a Series Resonant Circuit

Parallel Resonant Circuit-

(Current Magnification)

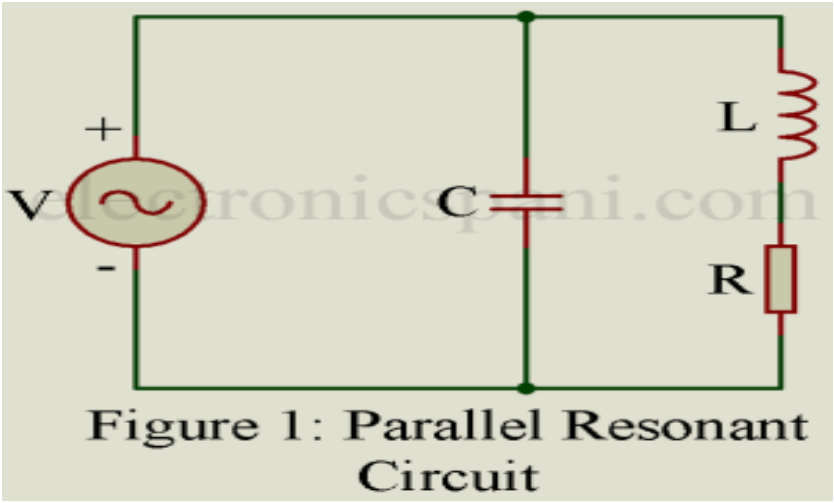
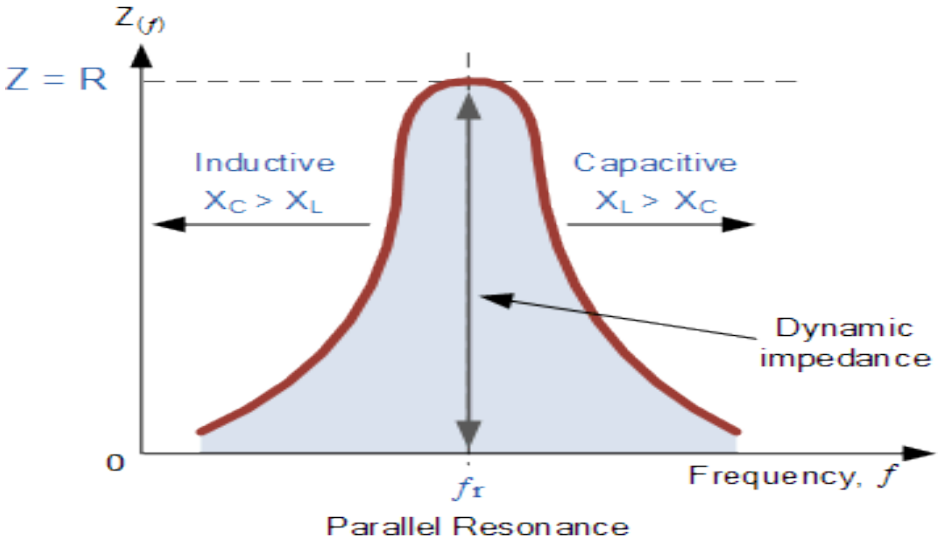


Figure 1: Parallel Resonant Circuit



Quality Factor(Q)- It is the measure of sharpness of resonance in the circuit.

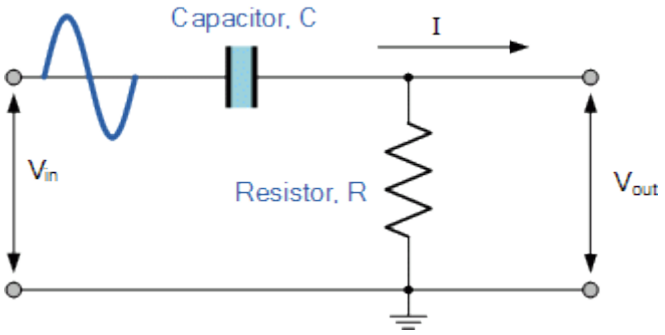
Quality Factor, $Q=X_L/R=\omega_r L/R$

Quality Factor, $Q=X_C/R=1/\omega_r CR$

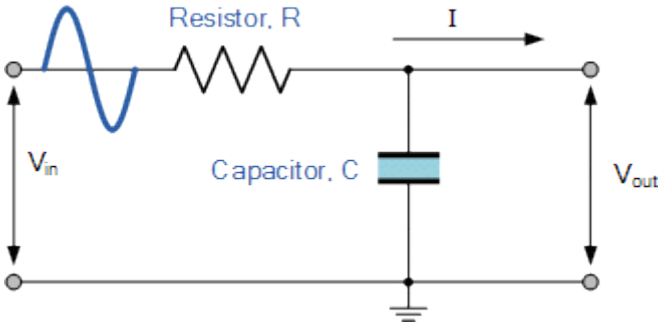
Comparison between Series and Parallel Resonant Circuits-

Sr. No.	Series Resonant Circuit	Parallel Resonant Circuit
1	The resonant frequency is given by $f_r=\frac{1}{2\Pi\sqrt{LC}}$ and is independent of resitance in the circuit.	The resonant frequency is given by $f_r=1/2\Pi\sqrt{\frac{1}{LC}-\frac{R2}{L2}}$ and is not independent of resitance in the circuit.
2	At resonance impedance Z is minimum.	At resonance, impedance Z is maximum.
3	At resonance, current is maximum.	At resonance current is minimum.
4	It is called acceptor circuit since it accepts the signal of one particular frequency and rejects all other frequencies.	It is called rejector circuit since it rejects the signal of one particular frequency and accepts all other frequencies.
5	Voltage magnification takes place.	Current magnification takes place.

High Pass Filter-

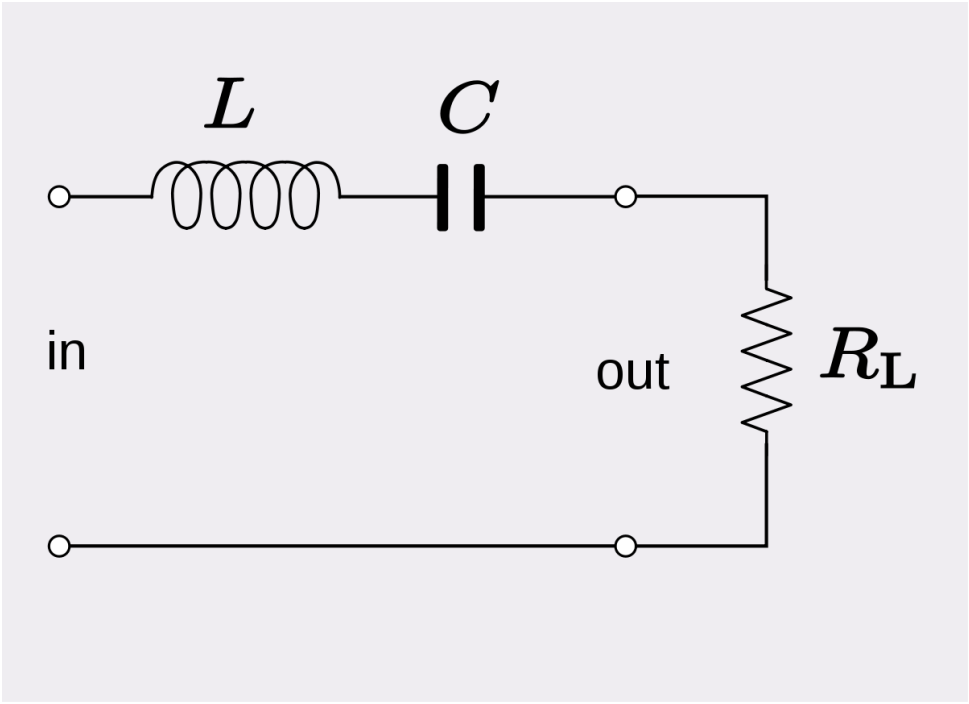


Low Pass Filter-

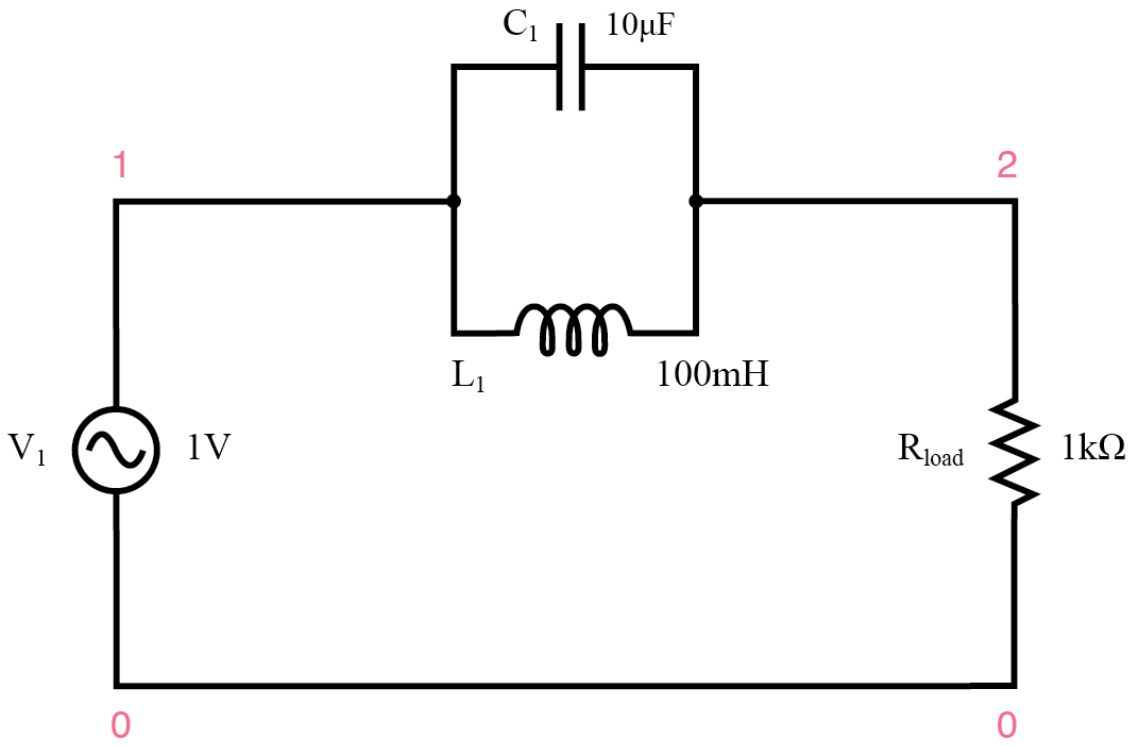


For both the filters, resonant frequency f_c=1/2ΠRC

Series Band Pass Filter-



Parallel band pass filter-



For both the band pass filters,

Quality Factor $Q=f_0/(f_H-f_L)$