# Electrical Engineering - 2023

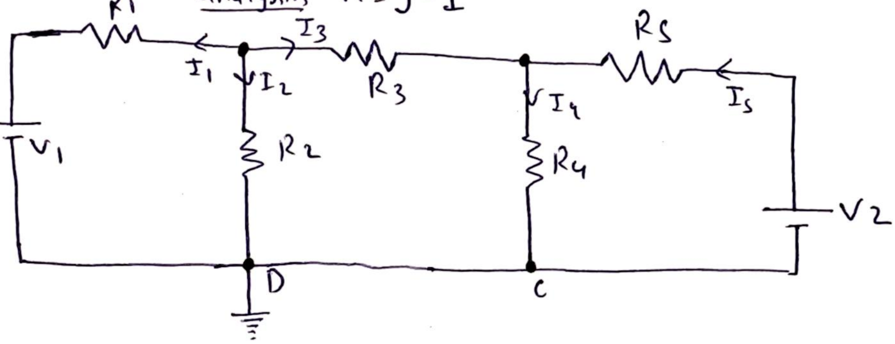
## Short Answer type question

1. Differentiate between loop and nodal analysis.

Node analysis.

- ~~Use~~ Node analysis uses Kirchhoff's current law.
- Node analysis method of finding the potential difference between the element or branch is an electric circuit
- Nodal method the number of independent node pair equation needed is one less than the number of Junction in the network. That is if n denotes the number of independent node equation and j is the number of Junction.

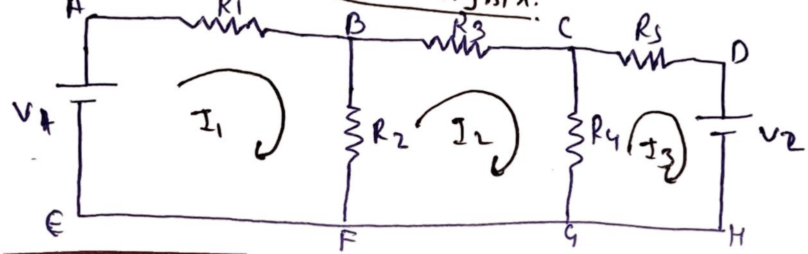
Circuit diagram of Nodal analysis $n = J - 1$




loop analysis.

- loop analysis use Kirchhoff's voltage law.
- In loop analysis method a distinct current is assumed in the loop and the polarities of drops in each element in the loop are determined by the assumed direction of loop current for that loop.
- In loop analysis any closed circuit the net voltage applied is equal to the sum of the product of current and resistance or in another word in any closed circuit the sum of the voltage rise is equal to the sum of voltage drop, in the direction of current flow.

Circuit diagram of loop analysis.



2. Classify source transformation.

Source transformation simply mean replacing one source by an equivalent source. A practial voltage source can be transformed into an equivalent practical current source and similarly a practical current source into voltage source.

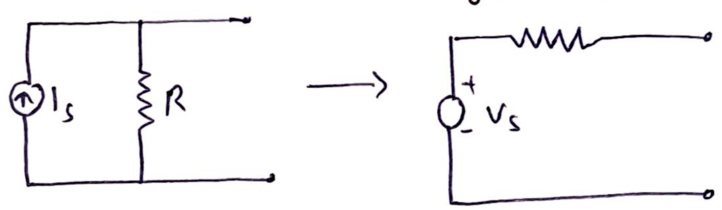
Type of source transformation.

1. Voltage source into current source.


When the voltage source is connected with the resistance in series and it has to be converted into the current source than the resistance is connected in parallel with the current source as shown in the above figure.

$$I_s = V_s / R.$$

2. Current source into voltage source.




In the above circuit diagram a ~~circuit~~ current source which is connected in parallel with the resistance is transformed in to voltage source by placing the resistance in series with the voltage source.

$$V_s = I_s / R.$$

3. Illustrate necessity and advantages of three-phase system.

A three-phase system is a widely used electrical power system that consist of three alternating current of the same frequency with each phase separated by 120°.

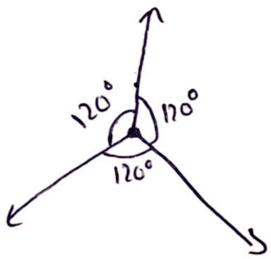
necessity of three-phase System.

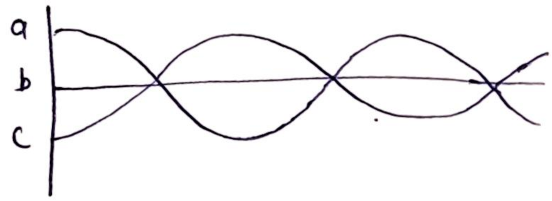
Increased power transmission efficiency :⇒ Power transmission and distributor is cheaper reliable. & more versatile in case of three-phase System.

Balanced load :- This is essential for high demand industries and grid requiring stable and efficient energy distrution.

Advantages of three-phase system.

- In Single phase circuit phase a pulsating bewer in a three phase circuit the power is constant.
- output of a three phase machine is more than single phase machine are given volume & weight.
- Three phase machine are smaller then single phase machine for given output.
- The phase machine have higher efficiency and power factor



4. Classify power losses in transformer.

losses in transformer.

Total power losses originating in a xmer under loaded condition can be classified in to the following groups.

Iron losses

Caused by varying magnetization and occur in xmer core. Iron losses can be further classified as "Hysteresis loss" and "Eddy loss"

Copper losses.

Caused by the flow of current and occur in primary and secondary winding

Hysteresis loss.

Occuring in the magnetic frame of the xmer depend upon the following.

(I) volume of the core

(II) frequency of magnetic flux.

Eddy current loss.

Is due to the flow of eddy current in the magnetic core and yoke of the xmer, caused by small emf induced in the magnetic frame.

(I) frequency of flux (f)

(II) volume of core.

(III) maximum value of flux density in core. (Bmax).

Copper losses.

In general copper losses in all these part of the xmer that carry electric current. Cu losses are directly proportional to.

(I) the squar of current

(II) Resistance.

Thus, Cu. occuring in the secondary winiding $= I^2_p R_p$,

Cu losses occuring in the secondary winding $= I_s^2 R_s$.

5. Classify different type of measuring instrument.

Devices which are aside to measure the electrical current, voltage Resistance and power as known as measuring instrument.

- Electrical instrument
  - Absolute instrument
  - Secondary Instrument
    - Analog Instrument
      - Deflecting Instrument
        - Indicating Instrument
        - Recording Instrument
        - Integrating Instrument
      - Null Deflecting Instrument
    - Digital Instrument

Absolute Instrument

This instrument give the value of the electrical quantity to measure in term of the constant and it deflection.

Galvanometer.

A galvanometer is an electromechanical measuring instrument for electric current measure the flow of current

Ammeter.

a ammeter is an instrument used to measured the current in a circuit.

Voltmeter

a voltmeter is an instrument used for measuring electric potential difference b/w two point

wattmeter.

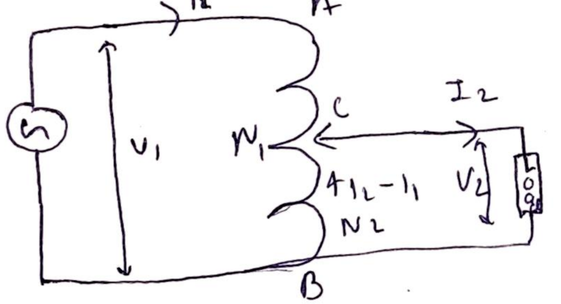
The wattmeter is an instrument for measuring the electric active power in watt of any given circuit.

6. Describe auto-transformer.

An auto-transformer with only one winding wound on a laminated core. An auto transformer is similar to a two winding transformer but differ in the way the primary and secondary winding are interrelated. A part of the winding is common to both primary and secondary side. On load condition, a part of the load current is obtained directly from the supply and the remaining part is obtained by transformer action.

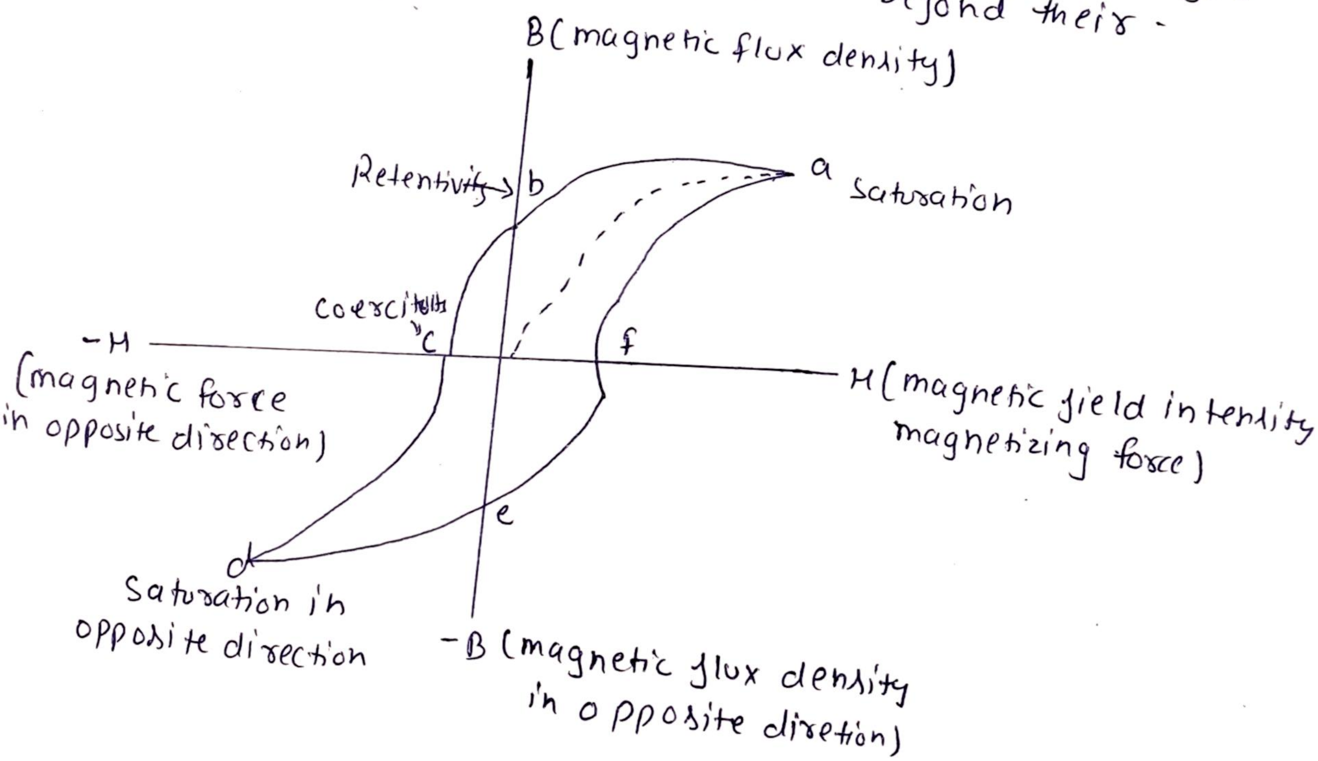
In an ordinary transformer, the primary and the secondary winding and electrically insulated from each other but connected magnetically as shown in the figure below. while in auto transformer the primary and the secondary winding are connected magnetcally as well as eletrically. In fact a part of the single continous winding is common to both primary and secondary.

There are two type of auto transformer based on the construction. In one type of tranforme, there is continous winding with the taps brought out at convenient point determined by the desired secondary voltage. in another type of auto transformer there are two or more distinct coil which are electrically connected to form a continous winding. the construction of auto transformer is show in the figure below.



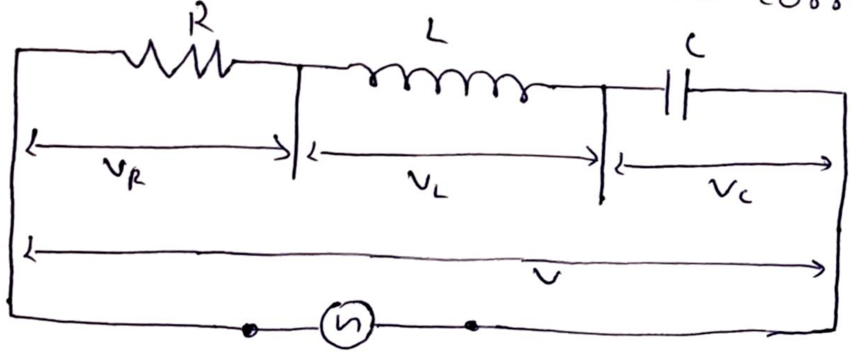
7. Discuss B-H curve

The hysteresis loop is a key feature of the BH curve of magnetic material. It respresent the energy loss the occurs when the magnetic material undergoes a complete cycle of magnetization and demagnetisation. The loop highlight the phenomenon where the magnetization lags behind the applied magnetic field.
The hysteresis loop is vital in understanding the energy losses in magnetic material used in transformer inductor and electrical motor. A large loop indicate grater energy loss, while a smaller loop indicate lower energy loss.
it offer a clear a understanding of a material magnetic properties, helping in the characterization of ferromagnetic material.
The area inside the hysterssis loop help in determined energy loss which is crucial for designing energy effecient devices.
Help in saturation point ~~inde~~ identification by analysing the curve the saturation point can be identified which is vital for ensuring that material do not operate beyond their magnetic capacity.



(Q) Explain R-L-C series circuit.

When a pure resistance of R ohm, a pure inductance of L Henry and a pure capacitor of C farads are connected together in series combination with each other then RLC Series ~~cir~~ circuit is formed. As all the three element are connected in series so, the current ~~fat~~ flowing through each element of the the circuit will be the same as the total current I flowing in the circuit.




$X_L = 2\pi f L$ and $X_C = 1/2\pi f C$

~~whean~~

when the AC voltage is applied through RLC Series circuit the resulting current I flow through the circuit and thus the voltage across each element will be

- $V_R = IR$ that is the voltage across the resistance R and is in phase with the current I.

  $V_L = IX_L$ that is the voltage across the inductance L and it leads the current I by an angle of $90°$.

  $V_C = IX_C$ that is the voltage across capacitor C and it lags the current by an angle of $90°$

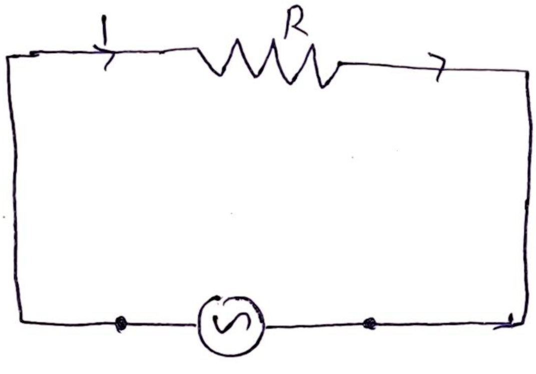
9. Explain pure resistive circuit.

The circuit containing only pure resistance of R ohms in the AC circuit is known as pure resistive AC circuit. the presence of inductance and capacitance does not exist in a purely resistive circuit. the alternating current and voltage both move forward as well as backwards in both the direction of the circuit. the alternating current and voltage follows a shape of the sine wave or known as the sinusoidal wave form.

In the purely resistive circuit, the power is dissipate by the resistors and the phase of the voltage and current remain same both the voltage and current reach their maximum value at the same time. The resistor is the passive device which neither produced nor consume electric power

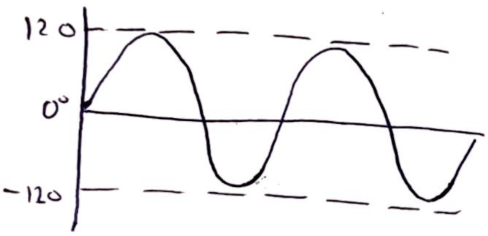
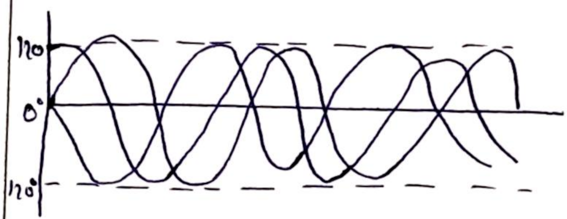
In an AC circuit, the ratio of voltage to current depend upon the supply frequency phase angle and phase difference

In an AC resistive circuit the value of resistance of the resistor will be same irrespective of the supply frequency



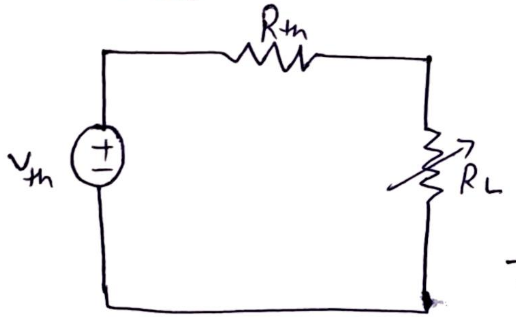

$V = V_m \sin \omega t$

10. Compare Single-phase ac System and three-phase ac System.

| Single-phase. | three-phase |
|---|---|
| • The Single phase requires two wire for compleating the circuit the conductor and the neutral the conductor carries the current and the neutral. The conductor carries the current. | • Three-phase System consist four wire, three conductor and one neutral. The conductor ar out of phase and space 120° apart from each other the three Phase System. |
|  |  |
| • The single phase carry 230°V | • The three phase carry 415V |
| • The Single phase has the minimum power transfer capability. | • The three phase have maximum power transfer capability. |
| • The Single phase has Simple Network | • The three phase has complicated Network. |
| • The Single Phase has maximum Loss | • The three Phase has minimum Loss |
| • The Single phase is used for home appliances | • The three Phase has used in large industries and for running heavy load. |

11. Explain maximum power transfer theorem

it Stats that theorem equivalent source the source will transfer the maximum power to load resistance if the value of load resistance is equal to the thevenin's equivalent resistance.




$$I_L = \frac{V_{th}}{R_L + R_{th}}$$

according to maximum power transfer theorem the source $V_{th}$ will transfer to load if $R_L = R_{th}$

Proof.

$$I_L = \frac{V_{th}}{R_{th} + R_L} \qquad P_L = I^2_L R_L$$

$$P_L = \left(\frac{V_{th}}{R_{th} + R_L}\right)^2 \cdot R_L$$

for maximum power transfer :- $\frac{dP_L}{dR_L} = 0$

$$\frac{dP_L}{dR_L} = \frac{d}{dR_L}\left[\left(\frac{V_{th}}{R_{th} + R_L}\right)^2 R_L\right] = 0$$

$$\frac{d}{dR_L} \frac{V^2_{th} \cdot R_L}{(R_{th} + R_L)^2} = 0$$

$$\frac{1}{[(R_{th}+R_L)^2]^2}\left[(R_{th}+R)^2 \frac{d}{dR_2}(V^2_{th} \cdot R_L) - V^2_{th} R_L \frac{d}{dR_L}(R_{th}+R_L)^2\right] = 0$$

$$\frac{1}{(R_{th}+R_2)^4}\left[(R_{th}+R_L)^2 \cdot V^2_{th} - V^2_{th} R_L \cdot 2(R_{th}+R_L)\right] = 0$$

$$\frac{R_{th}+R_L}{(R_{th}+R_L)^4}\left[(R_{th}+R_L)^2 V_{th} - V^2_{th} R_L \cdot 2\right] = 0$$

$$\frac{V^2_{th}}{(R_{th}+R_L)^3}\left[R_{th}+R_L - 2R_L\right] = 0$$

$$R_{th}+R_L - 2R_L = 0$$

$$R_{th}+R_L = 2R_L$$

$$\boxed{R_{th} = R_L}$$

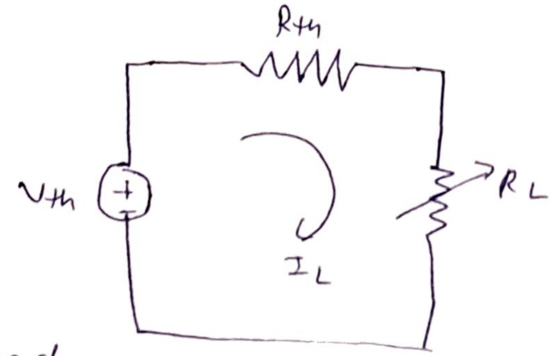
12. Illustrate Thevenin's theorem.

It stats that is any linear active bilateral network across it loud terminals can be replace by single voltage source and one series resistance

~~Prosigor~~

Procesor

1. first of all remove that load resistance if any.
II. Now determine the open circuit voltage across the load terminal by using max well loop (or) node method this is $V_{th}$ = thevenin's voltage.
III. Replace all independent source by there internal resistance now find the equivalent resistance add the load terminal $R_{th}$
IV. Now draw thevenin's equivalent circuit than connect the load resistance if any

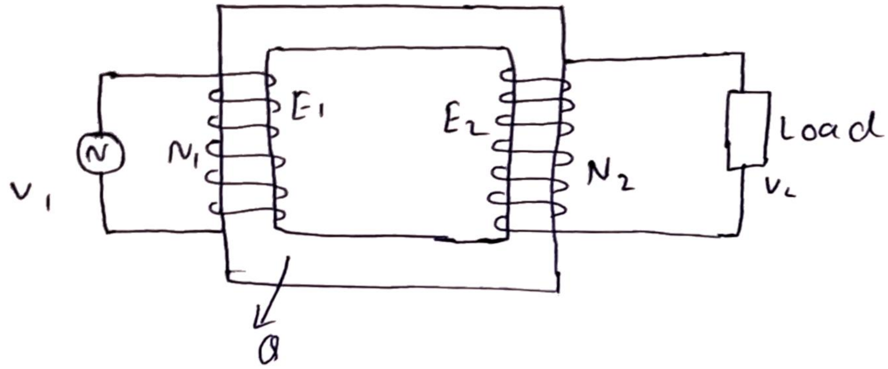



$I_L$ = load current
$V_{th}$ = Thevenin voltage
$R_{th}$ = Theuenis resistance

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

## Long Answer type question

1. Derive emf equation of transformer.




let us woside that $N_1$ & $N_2$ are the no of turns in the primary & Secondary respectively of a transformer let the primary winding is escited by a voltage V. Then voltage circulate x alternating current $I_1$ in the primary winding suppose FB is the frequency of supplied Voltage.

Due to ~~den~~ alternating current $I_1$ there is on alternating NMF ~~$N_1 X_1$~~ $N_1 I_1$ as a result an alternating flux.

The intantonus flux is given by

$$\phi = \phi_m \sin \omega t$$

$$\phi = \phi_m \sin 2\pi f t$$

where $\phi_m$ is the maximum value of flux in the core

- A self induced Emf in primary winding.
- A mutually induced Emf in the secondary winding.

$$e_1 = -N_1 \frac{d\phi}{dt}$$

$$= -N_1 \frac{d}{dt}(\phi_m \sin 2\pi f t)$$

$$= -N_1 \phi_m 2\pi f \cos 2\pi f t$$

$$= -N_1 \phi_m 2\pi f \sin(2\pi f t - \pi/2)$$

$$= N_1 \phi_m 2\pi f \sin\left(\frac{\pi}{2} - 2\pi f t\right)$$

thus we see that the emf induced in the coil, let the flux induced by an angle of 90°

$$E_{max} = \omega \phi_m N_1$$

$$E_{max} = N_1 \phi_m 2\pi f$$

$$E_{rms} = \frac{E_{max}}{\sqrt{2}} = E_1 = \frac{2\pi f N_1 \phi_m}{\sqrt{2}}$$

$$\boxed{E_1 = \sqrt{2}\pi f N_1 \phi_m}$$

$$\boxed{E_2 = \sqrt{2}\pi f N_2 \phi_m}$$

$$\phi = \phi_m \sin \omega t = \phi_m \sin 2\pi f t$$

$$e_1 = -N_1 \frac{d\phi}{dt}$$

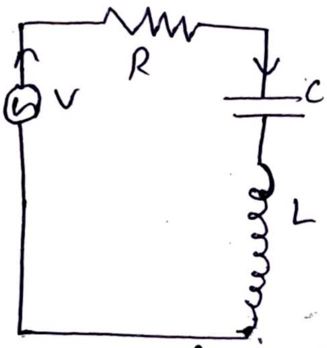
2. Explain resonance of R-L-C series circuit.

Resonance in AC Circuit implies a special frequeny determine by the value of the resistance, capactance inductance for series resonance in straigt forward and is characterised by minimum impedance and zero phase parallal resonace which is more common in electronic practice, requires a more carful defination.

minimum impendence at resonant frequncy.

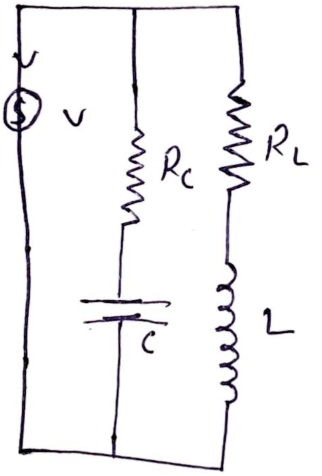
$I = \frac{V}{Z}$

$w_0 = \frac{1}{\sqrt{LC}}$




Series resonance.

minimum impendence at resonat frequency.




$w_0 \simeq \frac{1}{\sqrt{LC}}$

$I = \frac{V}{Z}$

Parallal resonance