11th May '2021 Module - 1 Question Bank Sout Solutions.

PART-A:-

1) Define the potential difference.

Potential difference is the different in the amount of energy that charge carriers have between two points in a circuit. The potential difference is measured in volts and is also called as voltage. We use a device named as voltmeter to measure potential difference.

2) Define Current.

An electric current is a stream of charged particle, such as electrons or ions, moving through an electric conductor or space. It is measured as the net rate of flow of electric charge through a surface or into a controled volume. Current is measured in Amperes.

3) Write the expression for voltage in terms of C & Q.

The formula is "Ohm's law" for capacitors. Here C is nor. of specific to capacitor, Q is the charge & V is voltage ~~across~~ across the capacitor

$$Q = CV.$$

or $$V = \frac{Q}{C}.$$

4) State Ohm's Law.

Ohm's law states that current through a conductor between two points is directly proportional to the potential difference across two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical expression that describes the relationship: $I = V/R$.

5) State Kirchoff's Law

There ~~at~~ are basically two Kirchoff's Laws.

→ Kirchoff's Current Law:- Also called as KCL or Kirchoff's first law and it states that the total current in a closed circuit, the entering current at node is equal to the current leaving at the node or the algebraic sum of current at node is electronic circuit is equal to zero.

→ Kirchoff's Voltage Law:- KVL or Kirchoff's 2nd law states that the algebraic sum of voltage in a closed circuit is equal to zero or the algebraic sum of voltage at node is equal to zero. Hence the sum of voltage difference across all the elements in the circuit is always zero.

6) Compare between practical sources and ideal sources

Ans:- The various type of voltage sources available in electric network are voltage source & current sources.

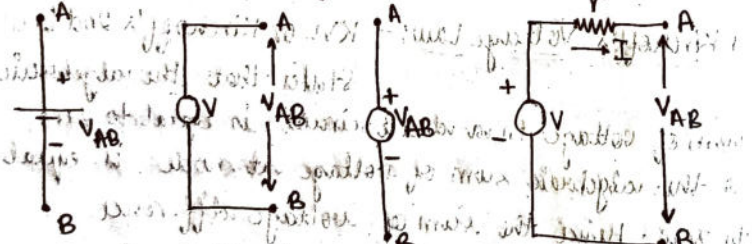
They are further divided into two types:-

Voltage Source → Ideal Voltage Source
→ Practical Voltage Source.

Current Source → Ideal Current Source
→ Practical current source.

A voltage source is a two terminal device, whose voltage at any instant of time is constant & is independent of the current drawn from it. Such voltage source is called as Ideal Voltage Source and have zero internal resistance.

Sources having some amount of internal resistances are known as Practical Voltage Source.



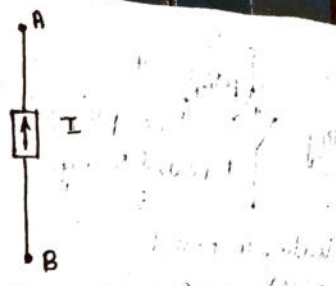
Ideal Voltage source

Practical Voltage Source.

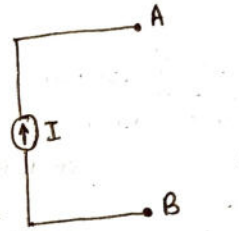
An ideal current source is a two terminal circuit element which supplies the same current to any load resistance connected across the terminals.

A practical current source is represented as an ideal current source connected with resistance in parallel.

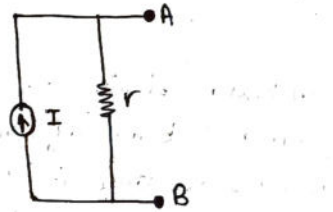
Ideal current source



Practical current source.



Ideal current source



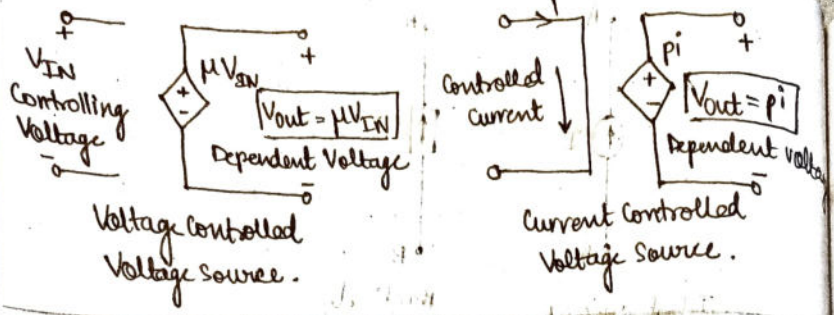
Practical current source.

7) Explain with relevant diagrams of dependent source

• Dependent Voltage Source :- Unlike ideal voltage source that produces a constant voltage across its terminals regardless of what is connected to it, a dependent voltage source changes its terminal voltage depending upon the voltage across or the current through some other elements connected to the circuit. It is sometimes difficult to specify the value of a dependent voltage source, unless you know the actual value of voltage or current on which it depends.

A voltage source that depends on voltage input is referred to as Voltage Controlled Voltage Source or VCVS.

A voltage source that depends on current input is referred to as Current Controlled Voltage Source or CCVS.



8) State two salient points of a series combination of resistors.

Ans:- In series combination the equivalent resistance is increased because of each resistance added. To increase resistance the resistors must be conducted in series.

In series the potential difference may change at different points.

9) Define Ideal Voltage Source & Current source.

- Ideal Voltage Source:- An ideal voltage source is defined as a two-terminal active element that is capable of supplying and maintaining the same voltage across its terminal regardless of the current flowing through it. An ideal voltage source will supply a constant voltage at all times regardless of the value of the current being supplied producing an I-V characteristic represented by a straight line.

- Ideal Current Source:- An ideal current source is a current source that supplies constant current to a circuit despite any other conditions present in the circuit. An ideal current source provides this constant current with 100% efficiency.

10) Write the expression of energy stored in a inductor and capacitor.

For an inductor, the outlet is magnetic field-the energy stored by an inductor is equal to the work needed to produce a current through the inductor. The formula for energy is given as:

$$E = \frac{1}{2} L I^2$$

L → Inductance (unit - Henry)

I → current (unit - Ampere).

For a capacitor if q_v is charge & C is capacitance and V is potential difference then

$$q_v = CV$$

$$dw = V\,dq_v = \frac{q_v}{C}\,dq_v$$

$$w = \int_0^q \frac{q_v}{C}\,dq_v = \frac{1}{C}\frac{q_v^2}{2} = \frac{1}{2}\frac{q_v^2}{C}$$

$$W = \frac{1}{2}\frac{q_v^2}{C} \qquad [\because q_v = CV]$$

$$V = \frac{1}{2} CV^2$$

V → potential difference

C → capacitance

Energy stored in capacitor.

11) State two salient points of parallel connections of resistors.

Ans:- • The potential diff across each resistor is same which is equal to the potential difference across each terminal of the battery.

• The current in the resistor is inversely proportional to the resistance. The sum of currents in separate branches of the parallel circuit drawn from the source i.e.,

$I_1 = I_1 + I_2 + I_3 + \dots$

12) Write properties of inductor.

• Inductors store kinetic energy in the form of magnetic energy. The formula for energy stored in the magnetic field is equal to $E = \frac{1}{2} LI^2$, where L is inductance and I is current.

• Inductors allow only direct current (DC) to pass through it while blocking the AC. These type of inductors are called as chokes.

• Inductors consume reactive power from the power source

• In a pure inductive circuits, the ei current lags behind voltage by 90°.

• Inductor oppose current change for alternating current.

13) Write properties of capacitor.

→ Working Voltage:- This is one of the important properties of capacitor which is defined as the maximum continuous voltage that can be applied to a capacitor before capacitor fails.

→ Tolerance:- Tolerance of a capacitor is determined with plus or minus values. These values are used for expressing the voltage percentage of a capacitor with higher values.

→ Working Temperature:- As the dielectrics property changes, there will be change in temperature which impacts the capacitance value, The working temperature of capacitor is between -30°C to +125°C.

→ Temperature Coefficient:- Temp coeff of capacitor is determined by calculating the maximum change in capacitance for specific temperature range.

(Q14) State limitation of Ohms law

Ans:- The limitation of ohm's law are explained below:-

1. This law cannot be applied to unilateral networks. A unilateral network has unilateral elements like diode, transistors, etc., which don't have same voltage current relation for both direction of current.

2. Ohm's law is not applicable for non-linear elements.

Q.15] Define conductance and state its units?

When voltage is applied to a piece of metal wire, the current I flowing through the wire is proportional to the voltage V across two points in the wire. This property is known as ohm's law. where $V = IR$ or $I = CV$

where R is the Resistance and G is called Conductance.

The resistance R and conductance G of the same piece of wire is related by $R = 1/G$. Resistance is measured in ohms & conductance is measured in siemens (S).

Q.15] Define conductance and

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PART-B:-

Q1) Differentiate resistor, inductor and capacitor elements using their voltage current characteristics.

Ans:- When voltage is applied to a piece of metal wire, the current I flowing through the wire is proportional to the voltage V across two points in the wire. This proportionality is known as Ohm's law. which reads

$$V = IR \text{ or } I = CV.$$

Here Resistance $= \frac{V \rightarrow \text{Voltage}}{I \rightarrow \text{current}}$

Resistance of Resistor is directly proportional to length & inversely proportional to area.

The power can be expressed as follows

$$P = VI$$

$$P = V \times \frac{V}{R} = \frac{V^2}{R} = CV^2 = I^2R.$$

If a changing flux is linked with a coil of conductor there would be an emf induced in it. The property of the coil of inducing emf due to changing flux linked with it is known as inductance of the coil. Due to this property all electrical coil can be referred as inductor.

Ohm's law for inductor is

$$V = L \frac{di}{dt}.$$

where V → instantaneous voltage across the inductor.

L → inductance in henry.

$\frac{di}{dt}$ → instantaneous rate of current change (amps per second).

The capacitor is the component which has the ability or "capacity" to store energy in the form of an electrical charge producing potential difference across its plates, much like a small rechargeable battery.

Ohm's law for capacitor is

$$i = C \frac{dv}{dt}.$$

where,

i → instantaneous current through capacitor.

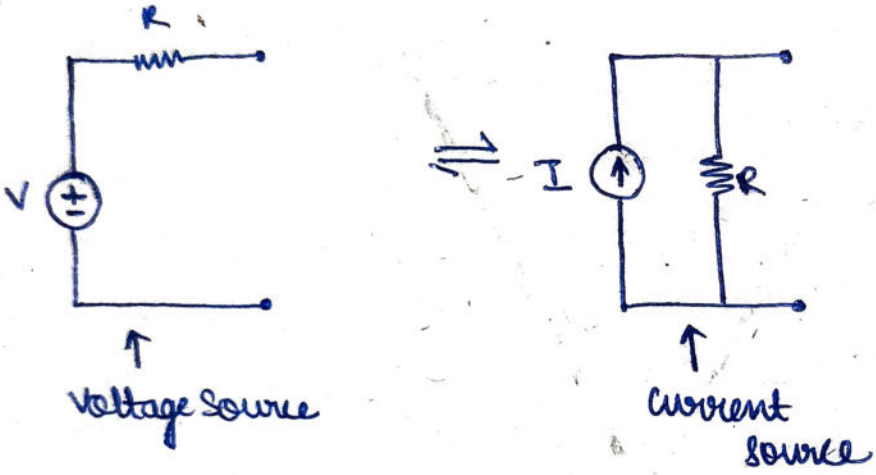
C → Capacitance in Farads

$\frac{dv}{dt}$ → Instantaneous rate of voltage change (volt per second).

2) Deduce the condition for source transformation and deduce one type of source from the other.

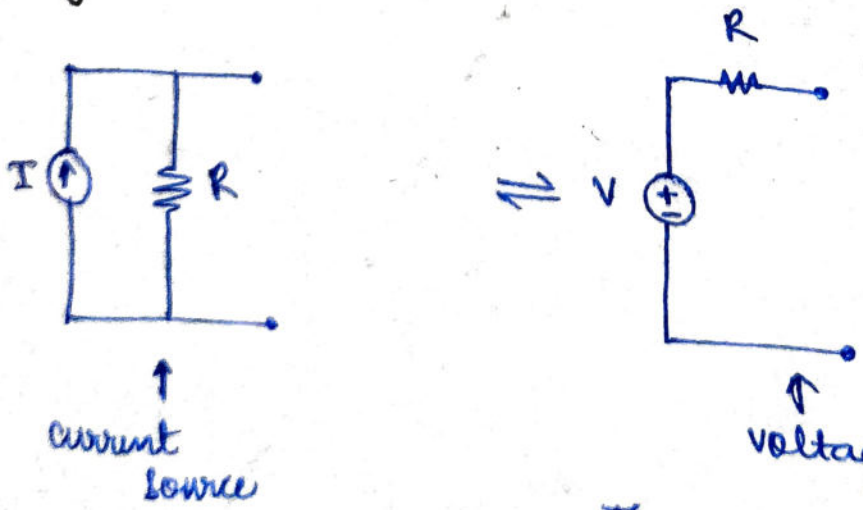
The condition for source transformation is that the voltage source should be in series with the resistor and the current source is required to be connected with a resistor parallel to the current source.

Source transformation for deducing current source from voltage source.



The current I is calculated by $\frac{V}{R}$.

Source transformation for deducing voltage source from that of current source.



The value of voltage can be calculated by the formula

$$V = IR.$$

(Q4) Classify types of elements in electric circuit depending on characteristics and explain in detail.

- **Active element :-** An element capable of delivering power to some other devices or elements in the network.

  Eg :- Energy sources.

- **Passive element :-** Element that are capable of receiving power.

  Eg :- Resistor, capacitor, inductor.

- **Unilateral Elements :-** V–I relationship is different for two possible directions of current flow or

These elements will allow current to flow only in one direction in any circuit.

Eg :- Diode.

- **Bilateral Elements :-** V–I relationship is same for either direction of current.

  Eg :- High conductivity materials, Resistor.

- **Linear Elements :-** The V–I characteristics is all the time a straight line passing through the origin.

  - linear networks satisfy the principle of superposition & homogeneity.

  Eg :- Resistor.

- **Non linear Elements :-** The element which doesnot satisfy superposition principle or VI characteristic are non-linear.

  Eg :- Diode.

- **Lumped Parameter :-** Elements are small in size compared to the wavelength of applied signal.

  Eg :- Resistors, capacitors, inductors.

- **Bilateral elements :-** Elements can't be separated electrically for analytical purpose.

  Eg :- Transmission lines.

Q5) Distinguish b/w ideal & practical energy sources.

- **Ideal Voltage Source:-** There is no resistance from the source and provide constant voltage independent of current type. Doesn't exists practically.

- **Practical Voltage Source:-** The source has some resistance & can't provide constant voltage for every load and can't provide unlimited current to load. It exists practically.

- **Ideal current source:-** An imaginary current source that provides constant current to any load ranging from zero to infinity. Current provided is independent of voltage.

- **Practical current source:-** Practical current source has some internal resistance and some of the current flow is through it & the amount of flow depends upon the load.

Q6) State ohm's law and give its applicability and electrical network. Explain conversion of current direction and voltage across an element.

STATEMENT:- At constant temperature the voltage across the terminal of conductor is proportional to the current flowing through it.

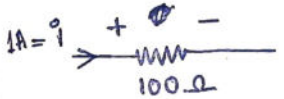
$V \propto I$

$V = IR$

R = Constant of proportionality known as resistance.

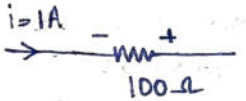
→ Applications :-

- Conventional domestic fan regulator are very common devices where the current through the fan get regulated by controlling the resistance of the regulator circuit.
- In voltage divider circuit this law is used to divide source voltage across output resistance.
- In electronic circuit, there are many applications where intentional voltage drop is required to supply specific voltage across different elements.
- In dc ammeter and other dc measuring instruments shut is used to divert current.



→ Then the sign convention is taken to be +ve so the value of V will be 100V.

But



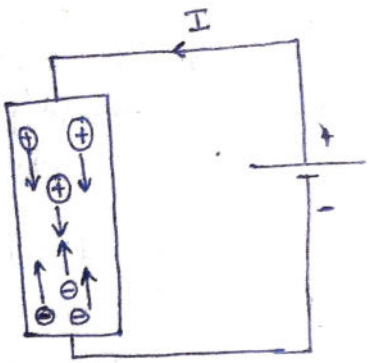
→ Then the sign convention is taken to be −ve so we get the value of V to be −100V.

This show that we have taken the polarity in opposite direction.

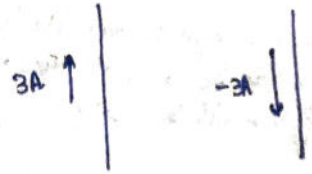
(Q7)

Q) Write the conventions to study any electrical circuit:

- **Current flow:-** The current flow is always taken in the direction of the charge movement, i.e., from the terminal to −ve terminal of the circuit

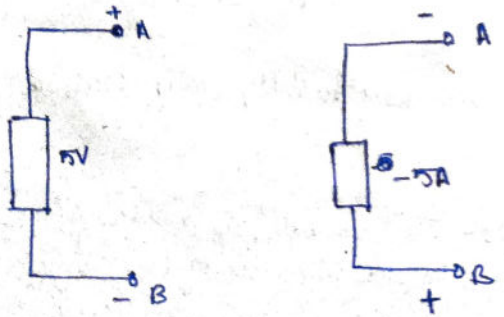


Direction of current flow :- If a current with +ve charge is flowing in one direction then the same magnitude of current ~~will flow~~ with negative charge will flow in the opposite direction.

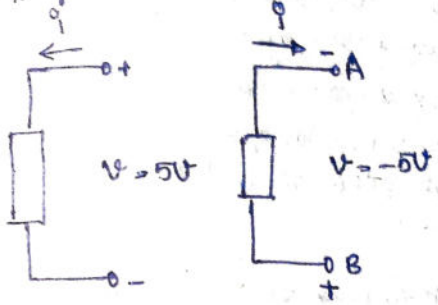


Voltage polarity :- The higher potential value of voltage is represented with +ve terminal & the other with -ve terminal.

Voltage drop from A to B is ~~opp~~ equivalent to voltage drop from B to A.



Power absorbed | delivered :- The power delivered to an element is denoted by +ve sign whereas power absorbed by an element is denoted as negative sign.



(Q8)

Define the term voltage, current, power, energy, node and degree of node.

→ Voltage :- Also called as electromotive force, it is a quantitative expression of potential difference in charge b/w two points in an electric field. Voltage is measured in volts & is measured by letter "V".

→ Current :- A flow of electricity that results from the ordered directional movement of electrically charged particle.

→ Power :- The rate at which the work is being done in an electrical circuit is called its power. The electric power is defined as rate of the transfer of energy.

→ Energy :- ~~The ability to do work, work~~ the energy derived from the potential or kinetic energy of the charged particle.

Q9). Define the term peak, peak to peak, average, RMS value, peak factor and form factor of sine wave.

→ **Peak**:- The maximum value attained by an alternating quantity during one cycle is called peak value. It is also known as maximum value or amplitude or crest value. The sinusoidal ~~wave~~ alternating quantity obtains its peak value at 90 degrees.

→ **Peak to Peak**:- Peak to peak value is the maximum voltage change during one cycle of alternating voltage or current. Also defined as the difference between positive peak and negative peak in AC.

→ **Average**:- It is defined as "the average of all instantaneous values during one alternation". The ratio of the sum of ~~all~~ considered ~~the~~ instantaneous values to the no of instantaneous values in one ~~alternation~~ alternation period.

→ **RMS Value**:- The "Root Mean Square" is the square root of the sum of squares of means of an alternating quantity.

→ **Peak factor** (of sine wave):- The ratio of max. value ~~of~~ to the RMS value of an alternating current. For a sine wave it is 1.41.

→ **Form factor** (of sine wave):- ~~The ratio b/w the average value & the RMS~~ Used to describe the physical size & shape. The form factor of sine wave is 1.11.

Q10). Derive the expression for average & rms value of sine wave.

Ans:- For a sine wave

Avg value = 0.637 * Maximum value

rms value = 0.707 * Maximum value.

Form factor = 1.11

Peak factor = 1.41

$$V_{avg} = \frac{1}{T}\int_0^T V_m \sin\omega t\, dt$$

$$V_{avg} = \frac{1}{\pi}\int_0^{\pi} V_m \sin\omega t\, dt = \frac{2V_m}{\pi}.$$

$$V_{avg} = 0.637 V_m.$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V(t)^2 d(\omega t)}$$

$$= \sqrt{\frac{1}{T}\int_0^T (V_m \sin\omega t)^2 d(\omega t)}$$

$$= \sqrt{\frac{1}{T}\int_0^T (V_m^2)\left(\frac{1-\cos 2\omega t}{2}\right) d(\omega t)}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} = 0.707 V_m.$$

Q11) Discuss the concept of Reactance and impedence offered by R, L, C parameters.

Reactance is measured in Ohm's but is given the symbol "X" to distinguish from pure resistive 'R' value.

Inductor Reactance is denoted as (X_L) measured in ohms

As the capacitor charges or discharges, a current flow through it which is restricted by internal impedence of the capacitor. This internal impedence is commonly known as Capacitive reactance and symbol is (X_C) in Ohm.

The impedence is defined as the ratio of sinusoidal voltage to the sinusoidal current. Also defined as total opposition offered to the flow of sinusoidal current. Hence impedence is measured in ohms.

The real part of the impedence is resistance and imaginery part is reactance.

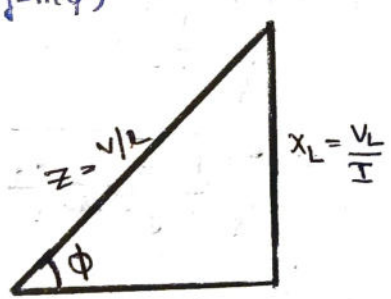
$$X_L = Z\sin\phi.$$

The series RL circuit.

$$Z = R + jX_L = Z(\cos\phi + j\sin\phi)$$

$$Z = |Z|\angle\phi$$

$$|Z| = \sqrt{R^2 + X_L^2} \qquad \phi = \tan^{-1}\left(\frac{X_L}{R}\right).$$



$$Z = R - jX_C = |Z|\angle -\phi$$

$$|Z| = \sqrt{R^2 + X_C^2} \; ; \; \phi = \tan^{-1}\left[\frac{-X_C}{R}\right]$$

$$X = X_L - X_C.$$

12) Explain the concept of susceptance and admittance offered by R, L, C ~~circuit~~ parameter.

In parallel circuit the inverse of the parameter will be useful as for analysis. The inverse of impedance is admittance. It is also defined as the ratio of sinusoidal current to voltage.

The general eq of admittance is given by

$$Y = G + jB \qquad G = \frac{1}{R}$$

G → conductance

B → susceptance $\qquad B = \frac{1}{X}$.

$$Y = \frac{1}{Z} = \frac{1}{R + jX} = \left(\frac{R}{R^2 + X^2}\right) + j\left(\frac{-X}{R^2 + X^2}\right).$$

and

$$B = \text{Im}(Y) = \frac{-X}{R^2 + X^2} = \frac{-X}{|Z|^2}$$

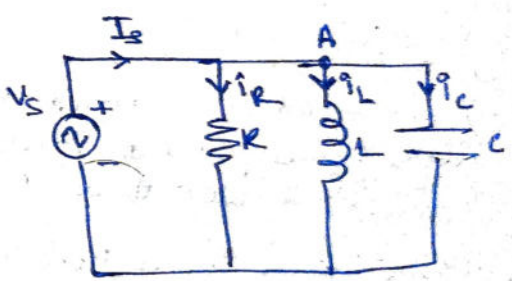
Where

$$Y = G + j(B_L - B_C)$$

$$Y = \sqrt{G^2 + (B_L - B_C)^2}$$

$$Y = \frac{1}{Z} \; ; \; G = \frac{1}{R}$$

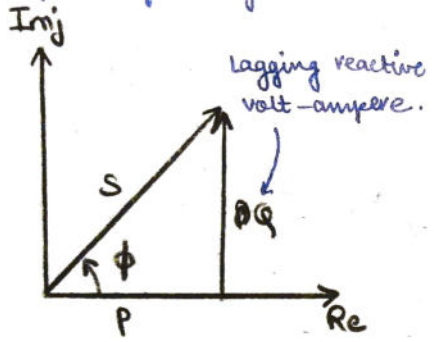
$$B_L = \frac{1}{\omega L} \; ; \; B_C = \omega C$$



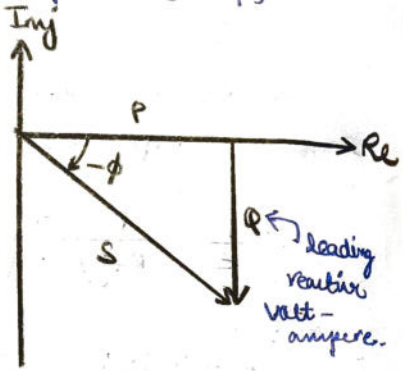
13). Compute all types of relations b/w two wave forms and write the relavant expressions.

14) Explain concept of active, reactive, apparent power and draw power triangle.

Power Δle is the representation of a right angle triangle showing the relation between active power, reactive power and apparent power. When each component of current i.e., active component (Icosϕ) or the reactive component (Isinϕ) is multiplied by voltage V.



(i) Lagging PF



(ii) Leading PF.

The power which is consumed or utilized in an AC circuit is called Torue power or Active Power or real power. It is measured in Kilowatt (or) MW.

The power which flows back and forth that means it moves in both the directions in the circuit or react upon it, it called Reactive Power. The reactive power is measured in KiloVolt-Ampere reactive (KVAR) or MVAR.

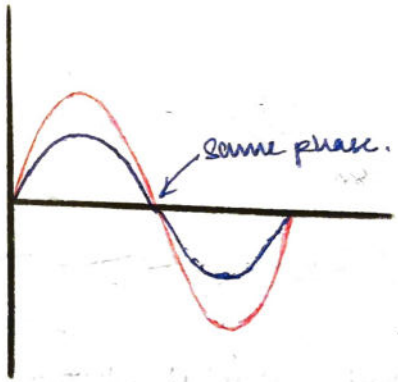
The product of root mean square (RMS) value of voltage & current is known as "Apparent Power". Measured in KVA or MVA.

15) Co-relate the impedance triangle with power triangle and explain in detail.

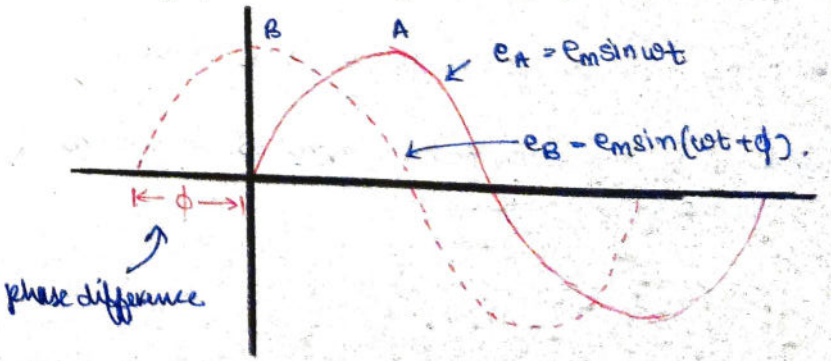
16) Explain the term phase, phase difference & phasor diagram with neat example.

→ Phase of wavefront :- The phase of an alternating quantity is defined as the divisional part of a cycle through which the quantity moves forward from a selected region.

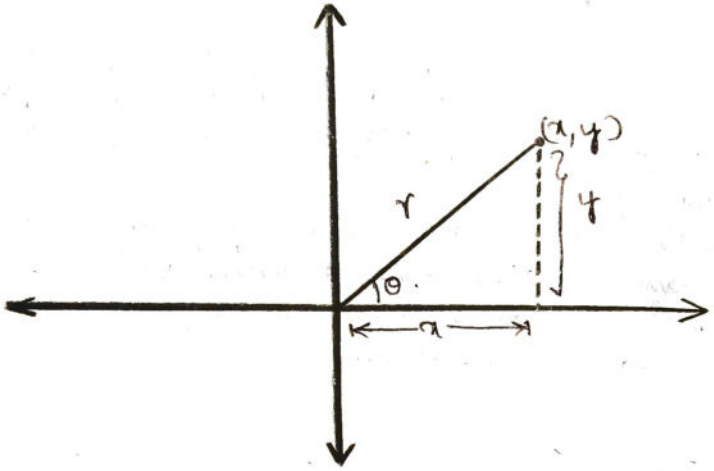
When two quantities have the same frequency, and their maximum & minimum point achieve at the same point acheive at same point, then the quantities are said to have in same phase.



→ Phase Difference :- The phase difference between the two electrical quantities is defined as the angular phase of difference b/w the maximum possible value of two alternating quantities having same frequency.



→ Phasor diagram:- Sinusoids are easily expressed in terms of phasors, which are more convenient to the work with the sine and cosine function. Phasors is the complex form can be represented polar and rectangular form.



- $r = \sqrt{x^2 + y^2}$; $\theta = \tan^{-1}\left(\frac{y}{x}\right)$.

$x = r\cos\theta$ and $y = r\sin\theta$.

16) Summarize ~~the nature of power factor in a inductive~~ & capacitive circuit.

17) Summarize the feature of electrical network with DC and AC excitation.

18) Explain nature of power factor in inductive & capacitive circuits.

19) Derive expression for true power in ac circuits.

20) Derive the expression for reactance and impedance of inductor & capacitance.

21) An electrical heater draws 3.5A from a 110V source. The resistance of heating element is approximately.

According to ohm's law.

$V = IR$.

↑ resistance.

So $R = \frac{V}{I}$.

$R = \frac{110}{3.5} = 31.42\ \Omega$.

23) A resistance is connected across 50V source. What is current in the resistor if the colour code is red, ~~orange~~ orange, orange, silver.

Red = 2

Orange = 3.

Silver = 10^{-2}

Tolerance = Silver = 10%.

23×10^3 or 23Kohm

$V = IR$

$I = \frac{V}{R} = \frac{50}{23K\ \Omega} = 2.17\ mA$.