LESSON 5

AC Circuits

BUVAS

LEARNING OBJECTIVES

The learning objective of AC circuit is preferably to know about RLC circuits, its advantages and disadvantages, three phase star / delta connection, interconnection of three phases and digital energy meter. According to the trend of applications, it is necessary to know the various types of connections in AC circuits.

Table of Content

5.1 AC CIRCUIT-INTRODUCTION

An alternating current supply may be generated in two methods:

(i) By rotating a coil at constant angular velocity in a uniform magnetic field

(ii) By rotating a magnetic field, constant angular velocity within a stationary coil

In both the cases, the generated voltage will be sinusoidal. The magnitude of generated voltage depends upon:

(i) Number of turns of the coil
(ii) The strength of magnetic field
(iii) The speed of rotation

The first method is used for small A.C generators and the second method is used for large type of A.C generators.

In fig. 5.1, an Alternating current shows the change in the direction of current and magnitude at regular intervals of power system. Alternating current plays a vital role in today's electrical energy generation.

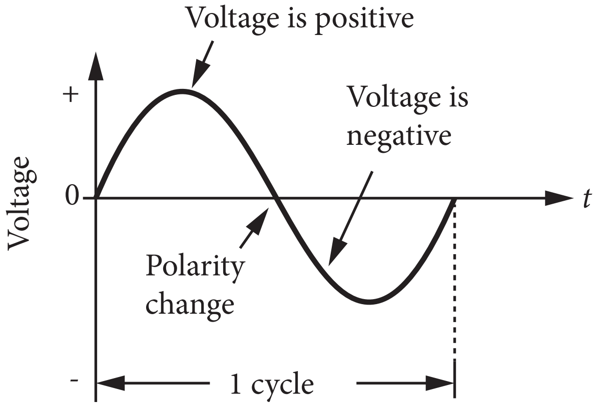


Fig 5.1 *Voltage vs Time*

5.2 AC WAVE FORM AND IT'S CHARACTERISTICS

A wave form is a representation of low alternating current (AC) that varies with time. The most familiar AC waveform is the sine wave, which derives its name from the fact that the current (or) voltage varies with the sine of the elapsed time.

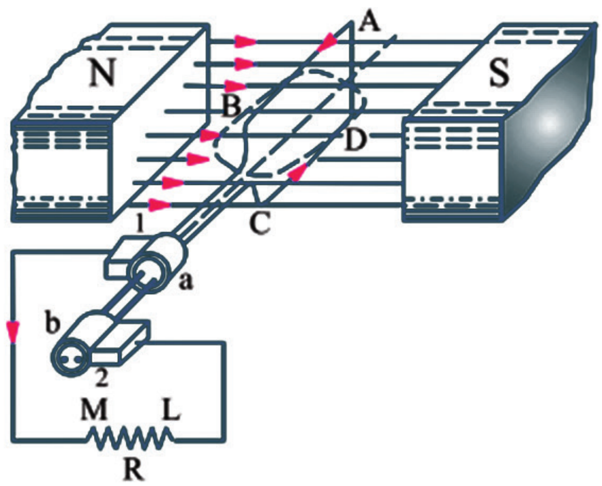


Fig 5.2(a) Schematic of an AC generator

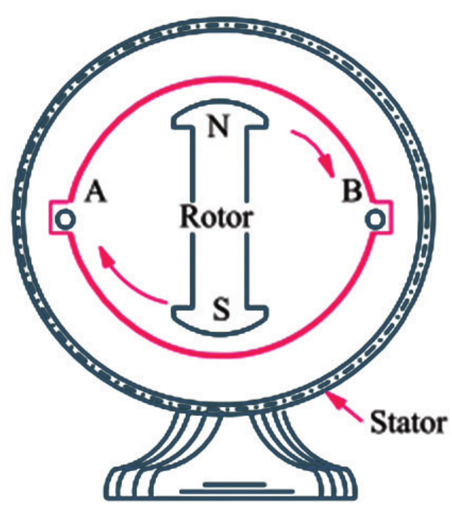


Fig 5.2(b) Sectional view of an AC generator

In fig 5.2 (a) A stationary magnetic field and rotating coil

In fig 5.2 (b) A stationary coil and magnetic field rotating

If a coil rotates in the magnetic field or rotates inside the coil, there is an alternating emf induced in the coil. The generated alternating emf depends upon the number of turns of coils, magnetic field and the angle between the coil and magnetic field.

Induced emf e = Blv Sinθ

Where

B = Flux density in weber/m^2

l = Length of the conductor in meter

v = Velocity of the conductor in meter/second

Ø = Angle between magnetic field and conductor

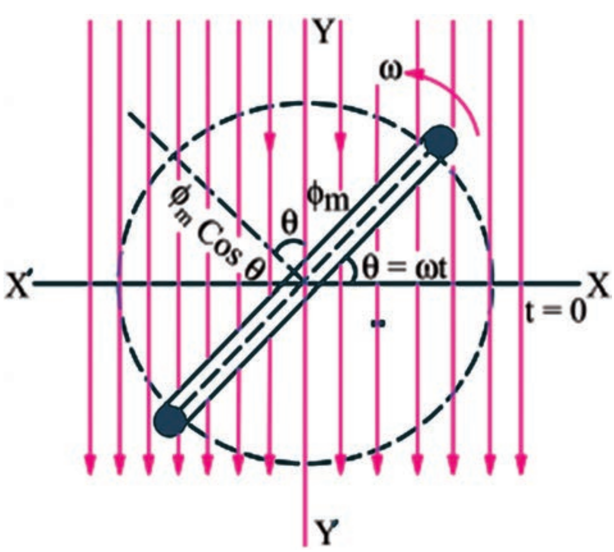


Fig 5.3 *Rotating coil in a magnetic field*

In fig. 5.3, a rectangular coil having 'N' turns and rotating in counter clock wise direction in a uniform magnetic field with an angular velocity of 'ω' radians/sec is shown.

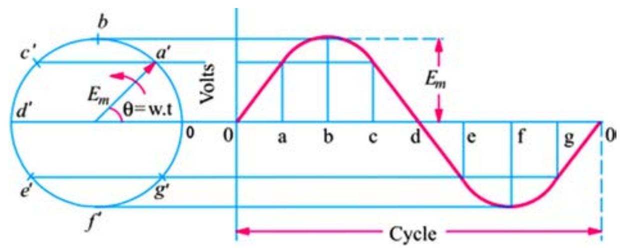


Fig 5.4 *Generation AC waveform*

So, the generated AC emf value is also depending upon the value of the angle between the magnetic field and the coil.

The sine wave may be drawn in graph by taking the electro motive force in 'Y' axis and time in 'X' axis.

In fig. 5.4, a coil is rotating in a magnetic field in anti-clock wise direction. Let us assume that the coil is in the position 'O'. Now the angle between the magnetic field and coil is zero. Then, the e.m.f in the coil is also zero (ie, sin θ = 0)

Now the coil moves to the position 'a' and the angle between the magnetic field and coil is θ. Then, emf is equal to Blv Sinθ.

Now the coil moves to the position 'b' and the angle between the magnetic field and coil is 90°. Then sin 90 = 1. The emf is maximum. This emf is called positive maximum.

Now the coil moves to the position 'd' and the angle between the magnetic field and coil is zero. In this position emf value is zero.

Now the coil moves to the position 'f' the angle between magnetic field and coil is 90°, sin 90° = 1 and the e.m.f is maximum in magnetic side, so it is called as negative maximum.

Now the conductor moves to the position '0', the emf is zero.

Similarly, the conductor rotates one revolution in the magnetic field. This rotation produces the sine wave form.

a) Cycle

One complete set of positive and negative values of alternating quantity is known as cycle. One complete cycle is said to spread over 360° or 2π radians.

b) Time period

Time period is denoted by 'T'. The time taken for any wave to complete one full cycle is called the time period.

c) Frequency

The frequency of a wave is defined as the number of cycles that a wave completes in one second. It is denoted by the letter 'F' and its unit is cycles / second or Hertz(Hz). In India, the supply frequency is 50Hz. Frequency is calculated by

$$f = \frac{PN}{120} \text{Hz}$$

Whereas

f = Frequency in Hertz
P = Number of poles
N = Revolution in r.p.m

d) Instantaneous value

At any given time, it has some instantaneous value. This value is different at different points along the waveform. During the positive and negative cycle, these values are positive and negative respectively.

e) Peak value

The peak value of the sine wave is the maximum value of the wave during positive half cycle or negative half cycle.

f) Peak factor

The ratio of maximum value to the r.m.s. value of an alternating quantity is known is peak factor

$$\text{Peak factor} = \frac{\text{Max. value}}{\text{RMS value}} = 1.414$$

g) Average value

The average value of the sine wave is the ratio of total area under the half-cycle curve to the distance of the curve

$$\text{Average value} = \frac{\text{Area under the curve}}{\text{Base length}}$$

$$\text{Average value} = \frac{2\text{Im}}{\neq} \text{ or } \frac{2\text{Vm}}{\neq}$$

h) Effective value or RMS value

The value of an Alternating Current (or) Voltage is equal to the square root of the arithmatic mean of the squares of the instantaneous values taken through one complete cycle.

$$\text{RMS value} = \frac{\text{Im}}{\sqrt{2}} \text{ or } \frac{\text{Em}}{\sqrt{2}}$$

AC ammeters and voltmeters are calibrated to record RMS values.

i) Form factor

The ratio of RMS value to the average value of an alternating quantity is known as form factor

$$\text{Form factor} = \frac{(\text{RMS value})}{(\text{Average value})} = 1.11$$

The form factor is useful in rectifier service because it enables to find the rms value from average value and vice versa.

j) Power factor

Cosine value of angle between voltage and current is called as power factor. Power factor is also defined as the ratio of true power to apparent power

Power factor = cos θ (θ is angle between voltage and current)

$$\text{Power factor} = \frac{VI\cos\theta}{VI} = \frac{\text{True power}}{\text{Apparent power}}$$

The power factor can never be greater than the value 1. If the powerfactor is 1, it is called as unity power factor. The word lagging or leading with the numerical value of power factor should be noted to signify whether the current lag or leads the voltage.

5.2.1 Phase

A particular value of an alternating quantity is the fractional part of the time period or cycle through which the quantity has advanced from the selected zero position of reference is known as phase.

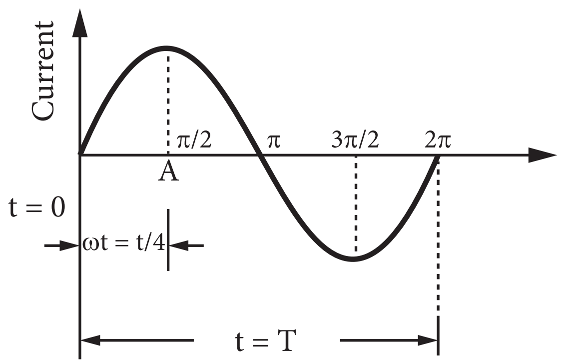


Fig 5.5 *Phase*

5.2.2 Phase difference

When two alternating quantities of the same frequency have different zero points, they are said to have a phase difference.

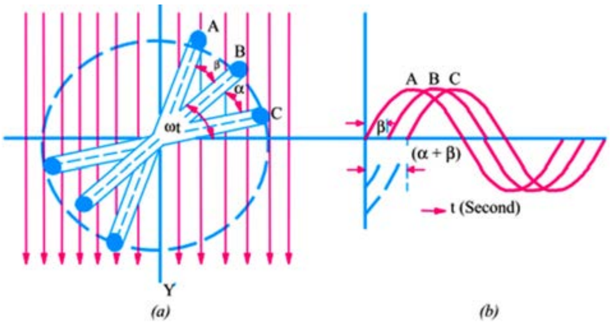


Fig 5.6 *Phase difference*

The angle in between the difference in the phase angle of the two wave is θ. It is generally measured in degrees or radians. The quantity which crosses through its zero point earlier is said to be leading while the other is said to be lagging.

5.3 ADVANTAGES AND DISADVANTAGES OF AC SUPPLY

Advantages

1) It is easy to transmit alternating current from one place to another place.
2) High voltage can be generated easily.
3) The cost of AC equipment is low.
4) It is possible to convert into DC.
5) Step down, step up voltage can be easily done by transformer.
6) AC motors are cheap.

Disadvantages

1) AC supply cannot be stored in batteries.

2) Ac supply produce high output. So it needs good insulation to avoid electric shock.
3) The voltage drop is occurred due to high starting current in AC.
4) The speed of the AC motor depends upon the frequency.
5) In Inductive load, power factor will be low.

5.4 TYPES OF ELECTRICAL ELEMENTS

There are two types of electrical elements.

1. Active elements
2. Passive elements

5.4.1 Active elements

Active elements produce energy in the form of voltage sources and current.

5.4.2 Passive elements

Passive elements consume energy. Some of the common examples of passive element are resistor, capacitor, inductor, etc.

5.4.3 Resistor – Types

Resistor is of two types. They are,

1. Fixed resistor and

2. Variable resistor.

(i) Fixed resistor

Resistors that have a defined value of the resistance are called fixed resistors.

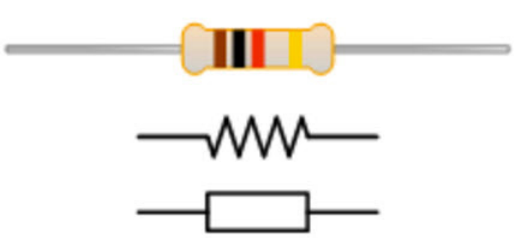


Fig 5.7 Resistor

(ii) Variable resistors

A variable resistor is a resistor, in which the value can be adjustable. A variable resistor is used with a potential divider having 3 terminals are known as a potentiometer.

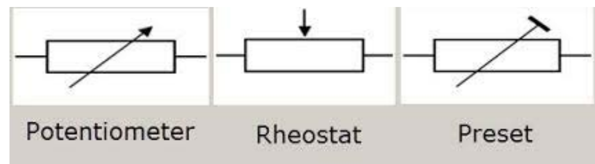


Fig 5.8 *Variable resistor*

5.4.4 Colour coding of resistors

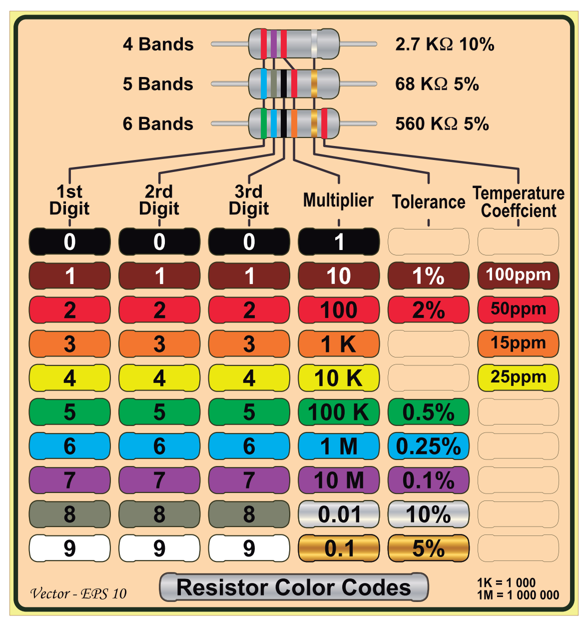


Fig 5.9 Colour coding of resistors

To calculate the resistance value, you have to group the values with the significant digits bands — i.e., the values of the first two or three bands from the left, depending on the total number of bands. Then multiply that value by the multiplier to get the resistance value.

Let's take for example a four-band resistor with the following band colors: Violet, Green, Yellow and Gold

Since it is a four-band resistor, the first two bands (violet and green) will indicate the significant digits, according to the table above is 75.

Then multiply that number by multiplier indicated with the 3rd band (yellow) which has the value of 104 = 10000.

The result of the multiplication will be: 75 x 10000 = 750000Ω = 750kΩ.

5.5 INDUCTOR AND INDUCTANCE

Inductance (L) is the tendency of an electrical conductor to oppose a change in the electric current flowing through it. A component which possesses the inductance property is called inductor.

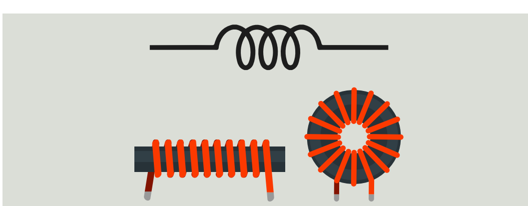


Fig 5.10 Inductor

5.5.1 Inductor in series circuit

Inductors in series are simply "added together" because the number of coil turns is effectively increased, with the total circuit inductance LT being equal to the sum of all the individual inductances added together as shown in fig.

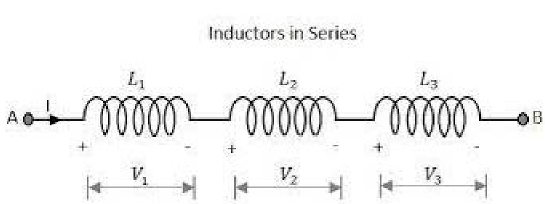


Fig 5.11 Inductors in series

The current (I) that flows through the first inductor L1 and pass through the second and third inductor.

$$V = L\left(\frac{di}{dt}\right)$$

$$L\ total = L_1 + L_2 + L_3 + ... + L_n ..$$

Inductors in parallel

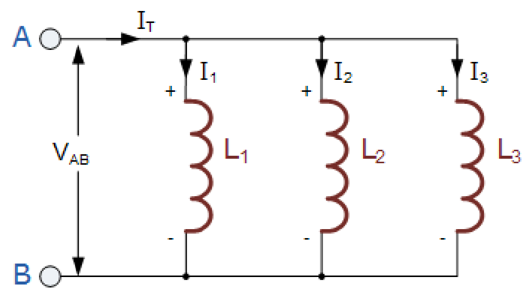


Fig 5.12 Inductors in parallel

When inductors are connected together in parallel so that the magnetic field of one links with the other, the effect of mutual inductance either increases or decreases the total inductance depending upon the amount of magnetic coupling that exists between the coils. The voltage drop across all of the inductors in parallel will be the same.

The voltage across the inductors is given as $V = L\left(\frac{di}{dt}\right)$

We can reduce it to give a final expression for calculating the total inductance of a circuit when connecting inductors in parallel and this is given as:

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + ... \frac{1}{L_N}$$

5.5.2 Capacitor in series circuit

When capacitors are connected in series, the total capacitance is less than any one of the series capacitors' individual capacitances. If two or more capacitors are connected in series, the overall effect is that of a single (equivalent) capacitor having the sum total of the plate spacing's of the individual capacitors.

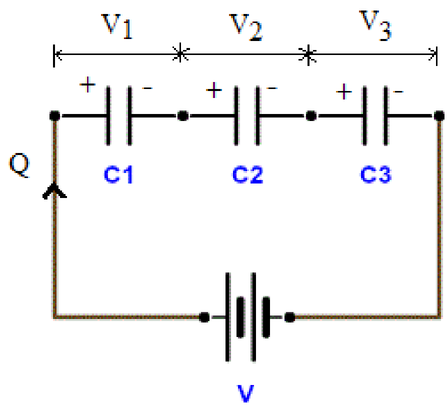


Fig 5.13 Capacitor in series circuit

We can find an expression for the total capacitance by considering the voltage across the individual capacitor as shown in above

The total capacitance in series cs to be

$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots\ldots$$

5.5.3 Capacitor in parallel circuit

Capacitors are connected together in parallel when both of its terminals are connected to each terminal of another capacitor. The sum of voltage connected across all the capacitors that are connected in parallel is same, as that of inductor in parallel.

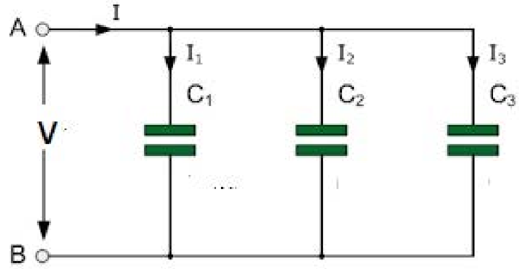


Fig 5.14 Capacitor in parallel circuit

5.5.4 Conditions for parallel

- Voltage rating of capacitors should be higher than the supply voltage Vs.
- Polarity should be maintained in the case of polarized capacitors (electrolytic capacitors).

Therefore,

$$C_T = C_1 + C_2 + C_3$$

5.6 RLC SERIES CIRCUITS

In this circuit, the three (RLC) components are all in series with the voltage source.

5.6.1 RLC series circuit

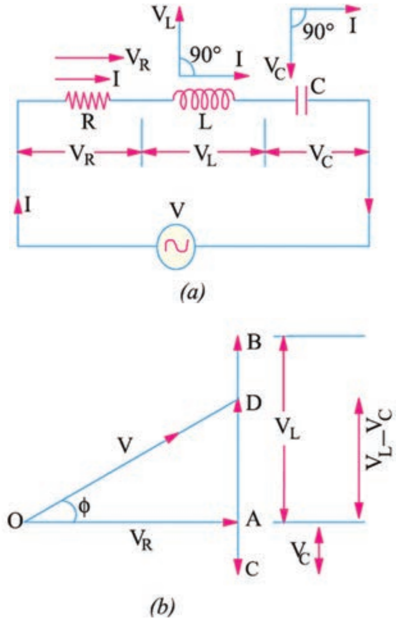


Fig 5.15 *RLC series circuit*

In this RLC circuit resistance, inductance and capacitance are connected in series. In this the current is same. The voltage is differed by circuit elements, Total supply voltage is 'V'

$I = I_R = I_L = Ic$

And

$V = V_R + V_L + V_C$

V_R = Voltage across the resistance

V_L = Voltage across the inductance

V_C = Voltage across the capacitance

And also

V_R is in phase with current

V_L leads current by 90°

V_C lags current by 90°

(i) If inductive reactance is greater than capacitive reactance ($X_L > X_C$)

$$V^2=V_R^2+(V_L-V_C)^2$$

$$V= \sqrt{V_R^2+(V_L- V_C)^2}$$

$$V = \sqrt{(IR)^2 + (IX_L - IX_C)^2}$$

$$V = \sqrt{I^2 R^2 + I^2 (X_L - X_C)^2}$$

$$V = I \sqrt{R^2 + (X_L - X_C)^2}$$

$$\frac{V}{I} = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\text{Impedance } Z = \sqrt{R^2 + \left(X_L > X_c\right) 2} \text{ ohms}$$

$$\left(\frac{V}{I} = Z\right)$$

$$\text{Power factor } \cos\theta = \frac{R}{Z}$$

$$\text{and power } P = VI \cos\theta \text{ watts}$$

(ii) If capacitive reactance is greater than inductive reactance ($X_C > X_L$)

$$\text{Impedance } Z = \sqrt{R^2 + (X_C > X_L)^2} \text{ ohms}$$

$$\text{Power factor } \cos\theta = \frac{R}{Z}$$

$$\text{And power } P = VI \cos\theta \text{ watts}$$

5.6.2. AC circuits with pure resistance

A circuit having only resistance and without inductance and capacitance is called pure resistance circuit

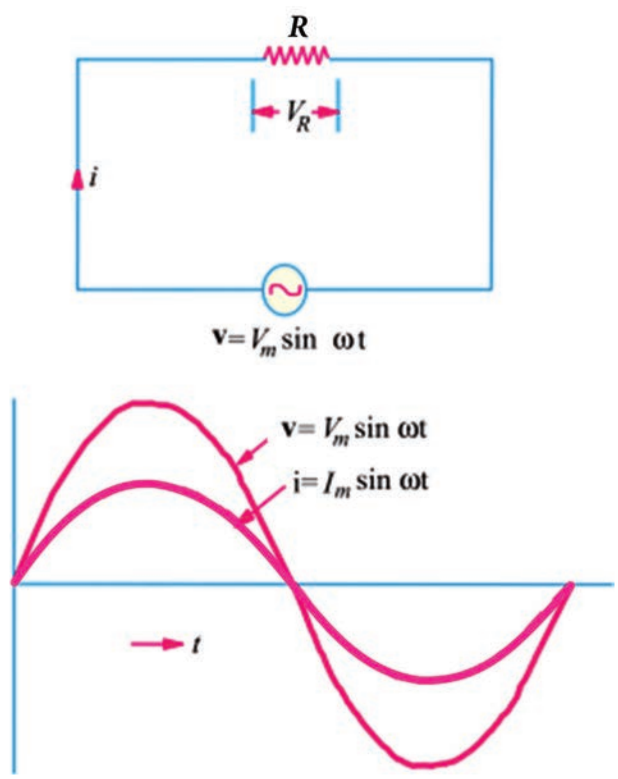


Fig 5.16 *AC through resistance*

Let

The value of resistance is R

The value of current is I

The value of electro motive force is E

Then

$$\text{Current}(I) = \frac{\text{Electromotive Force}(E)}{\text{Resistance}(R)}$$

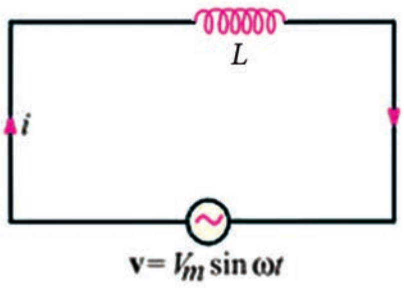
$$I = \frac{E}{R}$$

Power = Current × EMF

In this circuit power factor is unity, because the angle between current and voltage is zero ($\cos\theta = 1$).

5.6.3. AC circuits with pure Inductance

A circuit having only inductance and without resistance and capacitance is called pure inductance circuit.



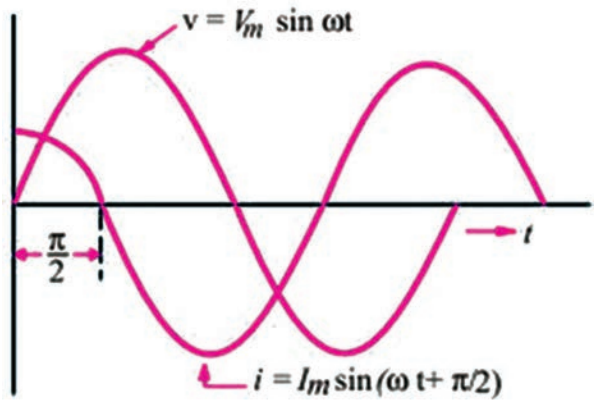


Fig 5.17 *AC through inductance*

If AC current flows through a coil, Back emf is induced due to inductance of the coil. This back emf opposes supplied voltage in a pure inductance coil. Back emf is equal to supply voltage. In inductive circuit only, the frequency is same for voltage and current, but they are out of phase and current is lagging by 90° to the voltage.Therefore power factor (cos 90=0)is zero.

5.6.4. Inductive reactance

Inductive reactance means the opposition due to self inductance to the AC current through a coil. It's unit is ohm and it is denoted by the letter "X_L"

$$X_L = 2\pi f L$$

Where

X_L-Inductive reactance in ohm
f-Frequency in Hertz
L-Inductance in Henry

5.6.5. AC Circuits with pure capacitance

A circuit having only capacitance and without resistance and inductance is called as pure capacitive circuit.

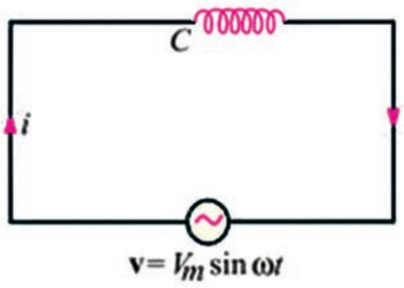


Fig 5.18 *AC through capacitance*

In the first half cycle (up to 90°) capacitor is charged and from 90° to 180° the capacitor is discharged. Similarly in the second half cycle, capacitor is charged first and discharged next, in opposite direction. So, in one cycle, capacitor is charged and discharged two times, in capacitor only. In AC circuit, the current is leading by the voltage at 90°. There fore power facter (Cos 90 = 0) is zero. So, power is zero.

5.6.6 Capacitive reactance

The resistance offered by a capacitor is called as capacitive reactance. The unit of capacitive reactance is ohm(Ω) and it is denoted by letters Xc.

$$Xc = \frac{1}{2\pi fc}$$

Where

Xc = Capacitive reactance in ohm
C = Capacitance in farad
F = Frequency in Hertz

5.6.7 Impedance

Impedance is the total opposition offered by the circuit elements [ie, Resistance, Inductance and Capacitance] simply, impedance is defined as the ratio of the voltage to current

$$\boxed{\text{Impedance (Z)} = \frac{\text{Voltage}(V)}{\text{Current}(I)}}$$

5.6.8 Diode

A diode is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction. When a diode is reverse-biased, it acts as an insulator and does not permit current to flow.

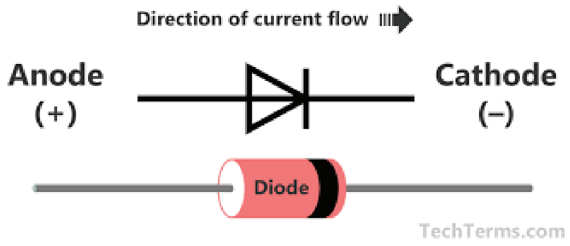


Fig 5.19 Diode

5.6.9 Transistor

"When a third doped element is added to a crystal diode in such a way that two pn junction formed, the resulting device is known as a transistor

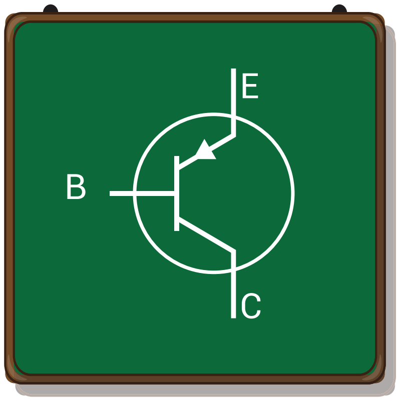


Fig 5.20 Transistor

5.6.10 Integrated circuit (IC)

Integrated circuit (IC) also called micro electronic circuit, micro chip, or chip. It is having an assembly of electronic components, fabricated as single unit, in which miniaturized active devices.

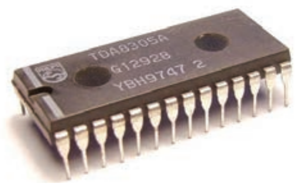


Fig 5.21 Integrated circuit

All IC's chips have a two-part serial number. The first part of the serial number indicates the manufacturer's information. The second part of the serial number indicates the IC's technical specifications. Many IC manufacturers produce identical chips with the same technical specifications

Acronym	Name	Year	Transistor count	Logic gate number
SSI	Small-scale integration	1964	1 to 10	1 to 12
MSI	Medium scale integration	1968	10 to 500	13 to 99
LSI	Large scale integration	1971	500 to 20000	100 to 9999
VLSI	Very Large scale integration	1980	20000 to 1000000	10000 to 99999
ULSI	Ultra large scale integration	1984	1000000 and more	100000 and more

5.6.11 Advantages of ICs

1. The integrated circuit can be easily replace but it can hardly repair, in case of failure.
2. The reduction in power consumption is achieved due to extremely small size of IC.
3. The weight and price of IC is very less.
4. The IC is more reliable.
5. The temperature difference between components of a circuit is less.
6. It is suitable for small signal operation.

5.6.12 Disadvantages of ICs

- The integrated circuit can handle only limited amount of power.
- The high grade PNP assembly is not possible.
- It is difficult to achieve low temperature coefficient.
- The power dissipation is limited to 10 watts.
- The inductors cannot be fabricated directly.

5.6.13 Application

Many integrated circuits can be found in almost every electronic devices such as Timers, Amplifiers, Logic units, Calculators, Temperature sensors, Computers and Radio receivers.

5.7 THREE PHASE STAR/ DELTA CONNECTION

3 phase AC generator is shown in Fig 5.13. Three identical windings A,B and C are placed 120^0 electrical degree apart. It generates 3 phase supply. Three phases are indicated in Red (R), Yellow (Y) and Blue (B) colors.

5.7.1 Poly phase system

If the armature of an alternator generating AC apply is having only one winding, it generates single phase supply. Instead of one winding, the alternator is having two or three windings, with two or three phases generated respectively. So a system produces more than one phase is called poly-phase system.

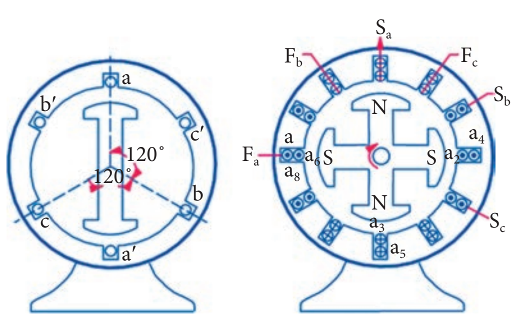


Fig 5.22 *Poly phase system generation*

5.7.2. Reasons for the use of three-phase system

Three phase system is preferred over single phase system for the following reasons.

Three phase power has a constant magnitude whereas single phase power pulsates from zero to peak value at twice the supply frequency.

A three phase system can set up a rotating magnetic field in stationary windings. This cannot be done with a single phase current.

For the same rating, Three phase machines (generators, motors, transformers) are smaller, simpler in construction and have better operation than single phase machines.

To transmit the same amount of power to a fixed distance at a given voltage. The three phase system requires only three-fourth weight of copper that is required by the single phase system.

The voltage regulation of a three phase transmission line is better than that of a single phase line.

5.7.3. Phase sequence

It is the term which is used to represent in what sequence the three phase voltage or current attains maximum value. If the phase sequence is said to be R, Y, B then first red phase attains maximum value with a phase difference of 120º each, the yellow phase and blue phase attains their peak value.

In a three phase alternator, there are three windings or phases. Each phase has two terminals. If a separate load is connected across each winding six conductors are required to transmit power. This will make the system complicated and expensive. In practice, three windings are interconnected to give two methods of connection.

Star (Y) connection

Mesh (Δ) connection.

5.7.4 Star ´Y´ Connection

In this method, similar ends of the three phases are joined together to form a common junction (N) supply is taken from other three ends. The common junction (N) is called the star point or netural point. The voltage between any one line and netural is called phase voltage. The current flows through that phase is called phase current. Voltage between any two line is called line voltage and current through that line is called line current.

In this connection,

Phase current = Line current

$I_{ph} = I_L$

$$\text{Phase voltage} = \frac{\text{Line voltage}}{\sqrt{3}} = \frac{V_L}{\sqrt{3}}$$

If the neutral wire is taken for external connection, then the system is called a three-phase four wire star connected system. If the neutral wire is not taken for external connection, then the system is called a three phase three wire star connected system.

Total power p = 3 × power in each phase

Power in each phase P = $V_{ph}\, I_{ph} \cos\theta$

$$P = 3 \times \frac{V_L}{\sqrt{3}} \times I_L \cos\theta$$

$$(\text{where as } I_{ph} = I_L, V_{ph} = \frac{V_L}{\sqrt{3}})$$

$$\therefore P = \sqrt{3} V_L I_L \cos\theta$$

5.7.5. Delta or Mesh Connection(Δ)

In this method of interconnection, the dissimilar ends of the three phase windings are joined together. The finishing end of one phase is connected to the starting end of the other phase so as to obtain Mesh or Delta connection. The three line conductors are taken from the three junctions of the Mesh or Delta and they designated as R, Y and B. This is called three phase three wire delta connected system. Since no neutral exists in Delta connection, only three phase, three wire system can be formed.

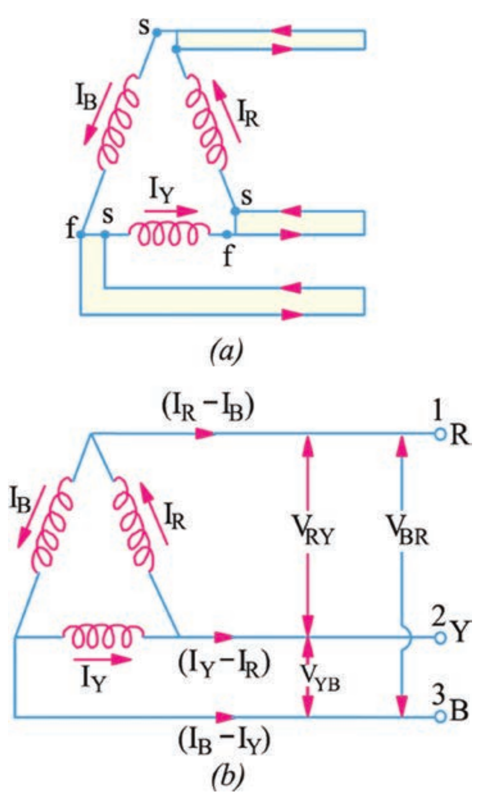


Fig 5.23 *Delta connection*

In this connection, the line voltage is equal to the phase voltage.

Phase volltage = Line voltage

$$V_{ph} = V_L$$

Phase current = Line current

$$I_{ph} = \frac{I_L}{\sqrt{3}}$$

Power

Total power P = 3 × power per phase

$$P = 3\, V_{ph}\, I_{ph} \cos\theta$$

$$P = 3 \times V_L \times \frac{I_L}{\sqrt{3}} \times \cos\theta$$

$$V_{ph} = I_L,\ I_{ph} = \frac{I_L}{\sqrt{3}}$$

$$\text{i.e., Power} = \sqrt{3}\, V_L I_L \cos\theta$$

Where cosθ is power factor.

5.7.6 Advantages of star connection over delta connected system

1. A star connected alternator will require less number of turns than a delta connected alternator for the same line voltage.
2. A star connected alternator requires less insulation over a Delta connected alternator for the same line voltage.
3. In star connection, Three-phase, Four-wire system permits to use two voltage ie, Phase voltage as well as line voltage.
4. In star connection, single phase load can be connected between any one line and the neutral. Such a flexibility is not available in Delta connections.
5. In star connection, the neutral point is earthed. Moreover, earthing of neutral permits to use protective devices to protect the system in case of any ground fault occurs.

5.8 SINGLE PHASE AND THREE PHASE SUPPLY

5.8.1. Single phase supply

In a single phase system, it consists of phase and neutral. The current will flow between them. The cyclical changes in magnitude and direction usually changes flow of current and voltage about 50 cycles per second.

The single-phase AC supply is utilized commonly for domestic purposes. Single phase supply = 230V, 5A and 50 Hz.

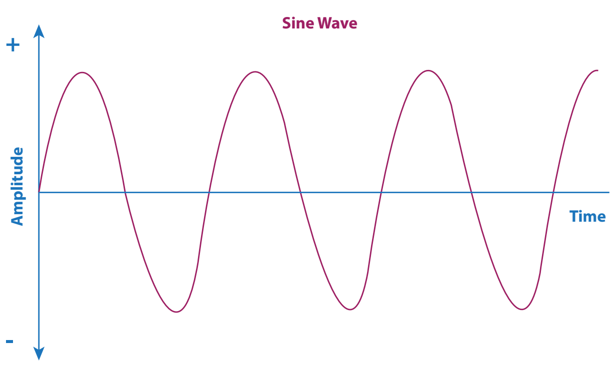


Fig 5.24 Single phase supply

Application of single phase power supply

Single-phase supplies are most commonly used in domestic loads such as lighting, fans, television, refrigerator and heating.

5.8.2. Three phase supply

The three-phase power supply includes four wires which consist of one neutral wire along with three conducting phase wires. The three conductors are away from phases and they have a phase angle of 120° from each other. The voltage of the three phase supply is 415V to 440V

Application of Three phase power supply:

Three phase power supply is used industries for heavy loads.

Points to Remember:

- ✶ Induced EMF e = Blv $\sin\theta$
- ✶ Frequency $f = \dfrac{PN}{120}$ Hz
- ✶ Average value = $\dfrac{2I_m}{\neq}$ or $\dfrac{2V_m}{\neq}$
- ✶ R.M.S. value = $\dfrac{I_m}{\sqrt{2}}$ or $\dfrac{V_m}{\sqrt{2}}$
- ✶ Form factor = $\dfrac{\text{RMS value}}{\text{Averagevalue}} = 1.11$
- ✶ Peak factor = $\dfrac{\text{Max. Value}}{\text{RMS Value}} = 1.414$
- ✶ Power factor= $\dfrac{V_I \cos\theta}{V_I}$
- ✶ In pure resistance circuit, power factor is one (unity)
- ✶ In pure inductive or capacitive circuit, power factor is zero
- ✶ Inductive reactance $X_L = 2\pi fL$
- ✶ Capacitive reactance $X_C = 1/2\pi f_C$
- ✶ Impedance $Z = \dfrac{V}{I}$

  In RLC series circuit power factor

$\cos\theta = \dfrac{R}{Z}$

Both in RLC series and parallel circuit

- ✶ Power P = VI $\cos\theta$ watts

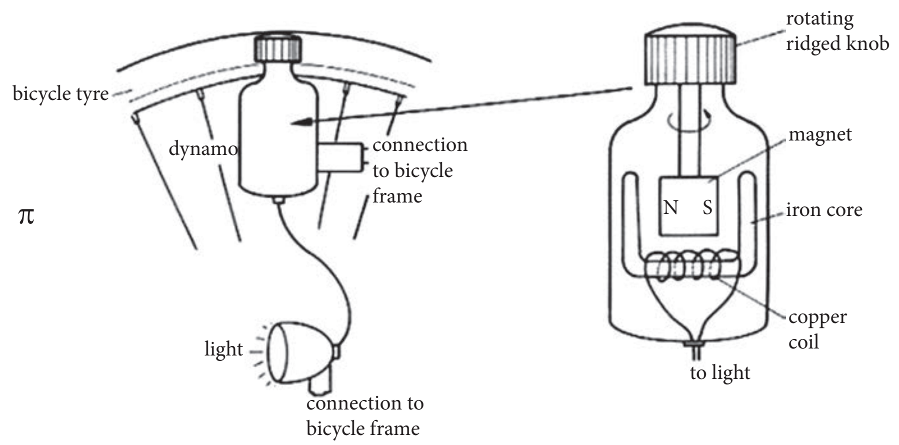
  In Star onnection

  Phase current = Line current

Activities

1. Practice the following (dynamo) type of voltage generation.

π π



GLOSSARY

AC supply	—	மாறுதிசை மின்சாரம்
Frequency	—	அலைவு வேகம்
Average value	—	சராசரி மதிப்பு
Peak value	—	உச்சமதிப்பு
Time period	—	கால அளவு
Instantaneous value	—	கன மதிப்பு
Effective value	—	பயன் மதிப்பு
Form factor	—	வடிவுக்காரணி
Peak factor	—	உச்சக்காரணி
Power factor	—	திறன்காரணி
Voltage sensor	—	மின்னழுத்த உணர்வி
Current sensor	—	மின்னோட்ட உணர்வி

Q A

PART A

Mark 1

8903Z

Choose the correct answer:

1. The unit of the frequency is
   a) Henry
   b) Hertz
   c) Cycles
   d) Ampere

2. The value of form factor is
   a) $2/\pi$ b) $\pi/2$
   c) 1.414 d) 1.11

3. In connected with the value of power factor, which is incorrect?
   a) Unity
   b) 0.8 leading
   c) 0.8 lagging
   d) 1.5

4. Power factor of pure resistive circuit is
   a) unity
   b) leading
   c) lagging
   d) less than one

5. The power factor of pure Inductive circuit, with respect to current is
   a) unity
   b) leading
   c) lagging
   d) Too much

6. Power factor of pure capacitive circuit, with respect to current is
   a) unity
   b) leading
   c) lagging
   d) Too much

7. The unity of Inductance is
   a) Henry
   b) Hertz
   c) Farad
   d) Ohm

8. The unit of capacitance is
   a) Henry
   b) Hertz
   c) Farad
   d) Ohm

9. What is the letter represents resistance?
   a) R b) C
   c) W d) V

10. The unit of the resistance is ____________
    a) volt b) ampere
    c) watts d) ohm

11. The resistance value is measured by ________
    a) ohm meter
    b) volt meter
    c) watt meter
    d) frequency meter

12. A variable resistor value is
    a) adjustable
    b) not adjustable
    c) fixed
    d) constant

13. How many types the electrical element consists of?
    a) Two
    b) Three
    c) Four
    d) one

14. When a diode is reverse-biased, it acts as
    a) conductor
    b) insulator
    c) biasing
    d) semi conductor

15. The unit of the flux density is
    a) Ampere
    b) Volt
    c) Weber
    d) Weber/m^2

16. In the value of power factor, which one is incorrect?
    a) Unity
    b) 0.8 leading
    c) 0.8 lagging
    d) 1.512

17. Power factor of pure resistive circuit is
    a) Unity
    b) Leading
    c) lagging
    d) greter than one

18. The unity of Inductance is
    a) Henry
    b) Hertz
    c) Farad
    d) Ohm

19. The unit of Impedance
    a) Henry
    b) Hertz
    c) Farad
    d) Ohm

Q A

PART B

Mark 3

Answer the questions in brief

1. State active components.
2. What is called electrical inductance?
3. Define the term transistor.
4. Write down the advantages of IC.
5. What are the applications of IC?
6. Define 'cycle' in an alternating current.
7. Define the form factor.
8. Define the peak factor
9. What are the uses of capacitor?
10. What is called phase sequence?

Q A

PART C

Mark 5

Answer the questions not exceeding one page

1. Draw a diagram of a series and parallel inductor circuit.
2. Explain AC circuit with resistance only.
3. Explain AC circuit with Inductance only.
4. What are the advantages of Star connection system?
5. Tabulate the advantages and disadvantages of IC.
6. What are the advantages of a three-phase power system?

Q A

PART D

Mark 10

Answer the questions not exceeding two page

1. Explain RLC series electrical circuits with a diagram.
2. Explain the three phase star connection with a neat diagram.
3. Explain the three phase delta connection with a neat diagram.

Reference book

1. 'A text book of Electrical Technology' Volume I, by B.L. Theraja and A.K. Theraja, S. Chand & Company Ltd.

Internet resource

www.allaboutcircuits.com