AUTOMOBILE MECHATRONICS

Basics of Electrical and Electronics Engg.

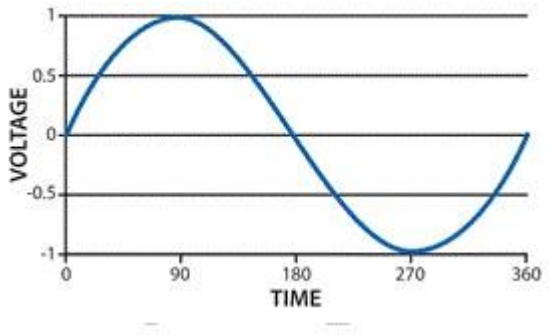
UNIT-2

Difference between Single Phase & Three Phase:

Both the power systems like single phase as well as three-phase uses AC power to refer units. Because the current flow using AC power is always in the directions of alternating. The main difference between these two supplies is the reliability of delivery.

Single Phase Supply:

In the field of electrical, single phase supply is the delivery of AC power by a system in which all the supply voltages change in simultaneously. This type of power supply sharing is used when the loads (home appliances) ate generally heat and lighting with some huge electric motors. When a single phase supply is connected to an AC motor doesn't generate a rotating magnetic field, single phase motors require extra circuits for working, but such electric motors are rare over in rating of 10 kW. In every cycle, a single phase system voltage achieves a peak-value two times; the direct power is not stable.



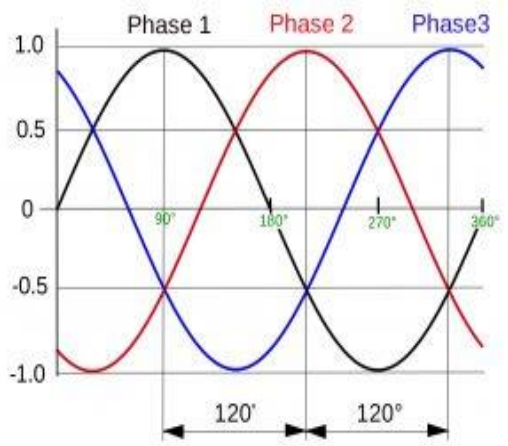
Single Phase Waveform

A load with single-phase can be power-driven from a three-phase sharing transformer in two techniques. One is with the connection between two phases or with connection among one phase and neutral. These two will give dissimilar voltages from a given power supply. This type of phase supply provides up to 230V. The applications of this supply mainly use for running the small home appliances like air conditioners, fans, heater, etc.

Three Phase Supply

The three-phase power supply includes four wires such as one neutral as well as three conductors. The three conductors are away from phase & space 120º distant from each other. Three phase power supplies are utilized as a single-phase AC power supply. For the small load, 1-phase AC power supply, as well as neutral, can be chosen from the 3-phase AC power supply system. This supply is constant and not at all totally falls to zero. The power of this system can be illustrated in two configurations namely star connection (or) delta connection. The connection of star configuration is used in long-distance communication as it includes a neutral cable to the error current.

Three Phase Supply Applications:



Applications of the three-phase supply include the following.

- These types of supplies are used in power grids, mobile towers, data centers, aircraft, shipboard, unmanned systems, as well as other electronic loads larger than 1000 watts.
- It is applicable to industrial, manufacturing, and large businesses.
- These are used in power-hungry and high-density data centers.

Differences between single phase and three phases include the following.

- The **definition of the single-phase** power supply is, the power supplies through a single conductor
- The **definition of the three-phase power** supply is, the power flows through three conductors.
- The single-phase power supply has one distinct wave cycle whereas; three phase has three distinct wave cycles.
- Single phase requires the single wire to connect the circuit whereas; 3-phase needs 3-wires.
- The voltage of the single phase is 230V, whereas three phase voltage is 415V.
- The phase name of the single phase is split phase, whereas three phase has no other name.

- The capacity of power transfer in the single phase is minimum, whereas three phase has the maximum.
- The connection of single phase is simple whereas in 3-phase is complicated.
- The power failure happens in a single phase, but not occurs in three phase.
- The loss in single phase is maximum whereas in three phase is minimum.
- The single-phase efficiency is less whereas in three phase is high.
- The single-phase is inexpensive whereas the 3-phase is expensive.
- The single-phase AC power supply is utilized for home appliances and three phase power supply is used in huge industries to run heavy loads.

Advantages of three-phase system over single phase systems:

The advantages of polyphase system over single phase systems are given below:

1. Power delivered is constant. In single phase circuit the power delivered is pulsating and objectionable for many applications.
2. For a given frame size a polyphase machine gives a higher output than a single phase machine.
3. Polyphase induction motors are self starting and are more efficient. Single phase motor has no starting torque and requires an auxiliary means for starting.
4. Comparing with single phase motor, three phase induction motor has higher power factor and efficiency.
   Three phase motors are very robust, relatively cheap, generally smaller, have self-starting properties, provide a steadier output and require little maintenance compared with single phase motors.
5. For transmitting the same amount of power at the same voltage, a three phase transmission line requires less conductor material than a single phase line. The three phase transmission system is so cheaper.
   For a given amount of power transmitted through a system, the three phase system requires conductors with a smaller cross-sectional area.
   This means a saving of copper and thus the original installation costs are less.
6. Polyphase motors have uniform torque whereas most of the single phase motors have pulsating torque.
7. Parallel operation of three-phase generators is simpler then that of single phase generator.
8. Polyphase system can set up rotating magnetic field in stationary windings.

comparison between single phase supply system and three phase supply system:

Single Phase Supply	Three Phase supply
• power delivered is pulsating	• Power delivered is constant

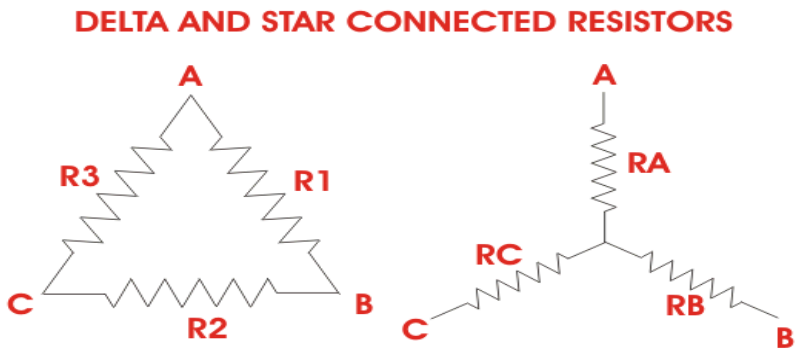
• Single Phase induction motors are not self starting as it does not have starting torque.	• Three phase induction motors are self st
• Parallel operation is not easy.	• Parallel Operation is easy.
• Efficiency of single phase motor is lesser.	• High efficiency.
• Single phase motors have pulsating torque.	• Three phase motors have uniform torque
• Single phase motors have lower power factor.	• Three phase motors have higher power f

Star To Delta Conversion :

Three branches in an electrical network can be connected in numbers of forms but most common among them is either star or delta form. In delta connection, three branches are so connected, that they form a closed loop. As these three branches are connected nose to tail, they form a triangular closed loop, this configuration is referred as delta connection. On the other hand, when either terminal of three branches is connected to a common point to form a Y like pattern is known as star connection. But these star and delta connections can be transformed from one form to another. For simplifying complex network, delta to star or **star to delta transformation** is often required.

Delta To Star Conversion:

The replacement of delta or mesh by equivalent star connection is known as **delta – star transformation**. The two connections are equivalent or identical to each other if the impedance is measured between any pair of lines. That means, the value of impedance will be the same if it is measured between any pair of lines irrespective of whether the delta is connected between the lines or its equivalent star is connected between that lines.



Consider a delta system that's three corner points are A, B and C as shown in the figure. Electrical resistance of the branch between points A and B, B and C and C and A are R_1, $R_2$and R_3 respectively.

The resistance between the points A and B will be,

$$R_{AB} = R_1||(R_2 + R_3) = \frac{R_1.(R_2 + R_3)}{R_1 + R_2 + R_3}$$

Now, one star system is connected to these points A, B, and C as shown in the figure. Three arms R_A, R_B and R_C of the star system are connected with A, B and C respectively. Now if we measure the resistance value between points A and B, we will get,

$$\boldsymbol{R_{AB} = R_A + R_B}$$

Since the two systems are identical, resistance measured between terminals A and B in both systems must be equal.

$$R_A + R_B = \frac{R_1.(R_2 + R_3)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (i)$$

Similarly, resistance between points B and C being equal in the two systems,

$$R_B + R_C = \frac{R_2.(R_3 + R_1)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (ii)$$

And resistance between points C and A being equal in the two systems,

$$R_C + R_A = \frac{R_3.(R_1 + R_2)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (iii)$$

Adding equations (I), (II) and (III) we get,

$$2(R_A + R_B + R_C) = \frac{2(R_1.R_2 + R_2.R_3 + R_3.R_1)}{R_1 + R_2 + R_3}$$

$$R_A + R_B + R_C = \frac{R_1.R_2 + R_2.R_3 + R_3.R_1}{R_1 + R_2 + R_3} \ldots\ldots\ldots (iv)$$

Subtracting equations (I), (II) and (III) from equation (IV) we get,

$$R_A = \frac{R_3.R_1}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots (v)$$

$$R_B = \frac{R_1.R_2}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots (vi)$$

$$R_C = \frac{R_2.R_3}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots (vii)$$

The relation of delta – star transformation can be expressed as follows.

The equivalent star resistance connected to a given terminal, is equal to the product of the two delta resistances connected to the same terminal divided by the sum of the delta connected resistances.

If the delta connected system has same resistance R at its three sides then equivalent star resistance r will be,

$$r = \frac{R.R}{R+R+R} = \frac{R}{3}$$

Star To Delta Conversion

For **star – delta transformation** we just multiply equations (v), (VI) and (VI), (VII) and (VII), (V) that is by doing (v) × (VI) + (VI) × (VII) + (VII) × (V) we get,

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1.{R_2}^2.R_3 + R_1.R_2.{R_3}^2 + {R_1}^2.R_2.R_3}{(R_1+R_2+R_3)^2}$$

$$= \frac{R_1.R_2.R_3(R_1+R_2+R_3)}{(R_1+R_2+R_3)^2}$$

$$= \frac{R_1.R_2.R_3}{R_1+R_2+R_3} .....(viii)$$

Now dividing equation (VIII) by equations (V), (VI) and equations (VII) separately we get,

$$R_3 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_1 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

$$R_2 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C}$$

Video Presentation of Delta to Star Transformation