# SYNCHRONOUS GENERATOR

**1. What Is Meant By Synchronizing The Alternators?**

**Answer:**

The process of connecting two or more alternators in parallel for supplying a common load is called synchronizing.

**2. What Are The Conditions To Be Satisfied For Proper Synchronizing Of Alternators?**

**Answer:**

1. The terminal voltage of the incoming alternator must be the same as bus-bar voltage.
2. The speed of the incoming alternator must be such that its frequency equals to the bus-bar frequency
3. The phase sequence of the incoming alternator must be the same as that of the other alternators or bus bars.

**3. What Are The Advantages Of Parallel Operation Of Alternators?**

**Answer:**

1. It ensures continuity of power supply to consumers in case of breakdown of an alternator in an generation station.
2. This is economical and improves the efficiency of the generating station.
3. When the demand of power increases, new alternators can be installed to operate in parallel.
4. It is not possible to built single large size alternator to meet the requirement.

**4. What Are Types Of Rotors Used In Alternators?**

**Answer:**

There are two types of rotors used in alternators namely

1. Salient pole rotor
2. Smooth cylindrical type rotor

**5. What Are The Advantages Of Providing Damper Winding?**

**Answer :**

The damper winding is useful in preventing the hunting ( momentary speed fluctuations) in generators.

The damper winding also used to maintain balanced 3 phase voltage under unbalanced load conditions.

**6. What Are The Various Methods To Determine The Voltage Regulation Of The Large Alternators?**

**Answer :**

In case of small machines, the regulation can be found by direct loading.

For large alternators, to find the voltage regulation indirect methods are used. They are

1. Synchronous Impedance Method.
2. The Ampere-turn method.
3. Zero power factor or Pointer Method.

**7. What Is The Basic Principle Of Alternators?**

**Answer :**

Alternators is noting but a AC generators. They operate on the fundamental principle of electromagnetic induction as dc generators.
ie, when the rotor rotates, the emf is induced in the stator.

**8. Which Type Of Rotor Is Suitable For Low Speed Alternators? Salient Pole Type Or Cylindrical Type Rotor?**

**Answer :**

Salient pole type alternators are suitable for low and medium speed alternators. It has large number of projecting poles. It has large diameters and short axial lengths.

**9. What Is Meant By Turbo Alternators?**

**Answer :**

High speed alternators are called as Turbo alternators.
As it runs at very high speed, salient pole rotors are not used. Smooth cylindrical type rotor is suitable for turbo alternators.

**24. What Is The General System Requirements Of Alternator?**

**Answer :**

For the generation of emf, there should be two basic systems.

1. magnetic field system to produce the magnetic field
2. Armature system which houses the conductors on which the EMF is to be induced.

**25. Will The Alternators Have Rotating Armature System Or Stationary Armature System?**

**Answer :**

Generally in alternators, the armature is stationary and the field rotates. Small lowvoltage alternators often have a rotating armature and a stationary field winding.But in large alternators rotating armature field type is used.

**26. What Are The Advantages Of Stationary Armature And Rotating Field System?**

**Answer :**

1. The stationary armature coils can be insulated easily.
2. Higher peripheral speed can be achieved in the rotor.
3. Cooling of the winding is more efficient.
4. Only two slip rings are required to give DC supply to the field system
5. Output current can be easily supplied to the load circuit. Sliprings and brushes are not necessary.

**27. What Is Meant By Stator? What Is Meant By Rotor?**

**Answer :**

In any electrical machine ( AC/DC motor or generator) the stationary member is called as stator. Similarly in all machines the rotating member is known as rotor.

**28. What Are The Advantages Of Three Phase Motor Over Single Phase Motor?**

**Answer :**

Three phase motors are having:

1. Higher starting torques
2. Improved speed regulation
3. Less vibration

4. Quieter operation

compared to the single phase motors.

**29. What Is Basic Principle Of Operation Of Alternators/dc Generators?**

**Answer :**

They are working on the fundamental principle based on Faraday's Laws of Electromagnetic Induction.

This law states that, When a current carrying conductor moves in magnetic field, it induces an EMF.

**30. How To Minimize The Eddy Current Losses?**

**Answer :**

When the core is laminated and insulated from each other with paper or varnish the eddy current loss is minimized.

**31. What Are The Various Types Of Rotors Used In The Alternators?**

**Answer :**

1. Salient pole rotor
2. Non salient pole rotor or Cylindrical rotor

**32. Define Pole Pitch?**

**Answer :**

The distance between the centres of two adjacent poles is called pole pitch. One pole pitch is equals to 180 electrical degrees. It is also defined as the number of slots per pole.

**33. Define Coil Span.?**

**Answer :**

The distance between the two coil sides of a coil is called as coil span. It may be expressed in electrical degrees or in number of slots.

**34. What Is Meant By Full Pitched Winding?**

**Answer :**

If the coil span is equal to pole pitch, the winding is called as full pitched winding.

**35. What Is Meant By Short Pitched Winding?**

**Answer :**

If the coil span is less than the pole pitch, the winding is called as shot pitched winding. It is also known as short chorded winding.

**36. What Are The Advantages And Disadvantages Of Short pitched Winding?**

**Answer :**

**The advantages are:**

1. They save copper for end connections
2. They improve the waveform of the generated EMF.
3. The generated EMF can be made to approximate to a sine wave more easily and the distorting harmonics can be reduced.

**The disadvantages are:**

1. The total voltage around the coils is somewhat reduced. Because the voltage induced in the two coil sides are slightly out of phase.

## SYNCHRONOUS MOTOR

**1. State the characteristic features of synchronous motor.**

Ans: a. the motor is not inherently self starting

b. The speed of operation is always in synchronous with the supply frequency irrespective of load conditions
c. The motor is capable of operating at any power factor.

**2. In what way synchronous motor is different from other motors?**
All dc and ac motors work on the same principle. Synchronous motor operates due to magnetic locking taking place between stator and rotor magnetic fields.

**3. Name any two methods of starting a synchronous motors**
- By an extra 3 phase cage induction motor
- By providing damper winding in pole phases
- By operating the pilot excitor as a dc motor

**4. What is the effect on speed if the load is increased on a 3 phase synchronous motor?**
The speed of operation remains constant from no load to maximum load in the motor operating at constant frequency bus bars.

**5. Why a synchronous motor is a constant speed motor**
Synchronous motor work on the principle of force developed due to the magnetic attraction established between the rotating magnetic field and the main pole feed. Since the speed of rotating magnetic field is directly proportional to frequency the motor operates at constant speed.

**6. What is the phasor relation between induced emf and terminal voltage of a 3 phase synchronous motor?**
The rotating magnetic field is initially established by the prime source of supply V. The main field then causes an emf e to get induced in the 3 phase winding. Hence when the machine operates as a synchronous motor the emf phasor always lags the terminal voltage phasor by the load1torque angle.

**7. At what load angle is power developed in a synchronous motor becomes its maximum value ?**
When its load angle is equal to the impedance angle .

**8. What are V and inverted V curves of synchronous motor ?**
The variation of magnitude of line current with respect to the field current is called V curve . The variation of power factor with respect to the field current is called inverted V curve.

**9. What happens when the field current of a synchronous motor is increased beyond the normal value at constant input?**

Increase in emf causes the motor to have reactive current in the leading direction. The additional leading reactive current causes the magnitude of line current, accompanied by the decrease in power factor.

**10.Distinguish between synchronous phase modifier and synchronous condenser**

A synchronous motor used to change the power factor or power factor in the supply lines is called synchronous phase modifier.

A synchronous motor operated at no load with over excitation condition to draw large leading reactive current and power is called a synchronous condenser.

## INDUCTION MOTOR

**1. What Is An Induction Motor?**

**Answer :**

An induction motor (IM) is a type of asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction.

**2. What Is An Electric Motor?**

**Answer :**

An Electric Motor converts electrical power to mechanical power in its rotor.

**3. How To Supply Power To Rotor?**

**Answer :**

In a DC motor this power is supplied to the armature directly from a DC source, while in an AC motor this power is induced in the rotating device.

**4. Why An Induction Motor Sometimes Called Rotating Transformer?**

**Answer :**

An induction motor is sometimes called a rotating transformer because the stator (stationary part) is essentially the primary side of the transformer and the rotor (rotating part) is the secondary side.

**5. Who Invented Induction Motor?**

**Answer :**

Nikola Tesla.

**6. What Is The Basic Difference Between Synchronous Motor And An Induction Motor?**

**Answer :**

The basic difference between an induction motor and a synchronous AC motor is that in the latter a current is supplied onto the rotor. This then creates a magnetic field which, through magnetic interaction, links to the rotating magnetic field in the stator which in turn causes the rotor to turn. It is called synchronous because at steady state the speed of the rotor is the same as the speed of the rotating magnetic field in the stator.

**7. Why Stator Windings Are Arranged Around The Rotor?**

**Answer :**

the induction motor does not have any direct supply onto the rotor; instead, a secondary current is induced in the rotor. To achieve this, stator windings are arranged

around the rotor so that when energised with a polyphase supply they create a rotating magnetic field pattern which sweeps past the rotor. This changing magnetic field pattern can induce currents in the rotor conductors. These currents interact with the rotating magnetic field created by the stator and the rotor will turn.

**8. Why The Speed Of The Physical Rotor And The Speed Of The Rotating Magnetic Field In The Stator Must Be Different?**

**Answer :**

The speed of the physical rotor and the speed of the rotating magnetic field in the stator must be different, or else the magnetic field will not be moving relative to the rotor conductors and no currents will be induced.

**9. What Is The Slip?**

**Answer :**

This difference between the speed of the rotor and speed of the rotating magnetic field in the stator is called slip. It is unitless and is the ratio between the relative speed of the magnetic field as seen by the rotor to the speed of the rotating field. Due to this an induction motor is sometimes referred to as an asynchronous machine.

**10. How Many Types Of Induction Motor ?**

**Answer :**

**Based on type of phase supply:**

1. Three phase induction motor (self-starting in nature)
2. Single phase induction motor (not self-starting)

**Other:**

1. Squirrel-cage induction motor
2. Slip ring induction motor

**11. What Is A Stator?**

**Answer :**

The stator consists of wound 'poles' that carry the supply current that induces a magnetic field in the conductor. The number of 'poles' can vary between motor types but the poles are always in pairs (i.e. 2, 4, 6, etc.).

**12. How Many Types Of Rotor Are There?**

**Answer :**

**There are two types of Rotors:**

1. Squirrel Cage rotor.
2. Slip Ring rotor.

**13. What Techniques Is Used To Produce A Desired Speed?**

**Answer :**

The most commonly used technique is Pulse Width Modulation in which a DC signal is switched on and off very rapidly, producing a sequence of electrical pulses to the inductor windings.

**14. What Is The Difference Between Dc Motors And The Induction Motors?**

**Answer :**

The induction motor has no brushes and is easy to control, many older DC motors are being replaced with induction motors and accompanying inverters in industrial applications.

**15. How An Induction Motor Is Started? Why The Starter Is Used?**

**Answer :**

When the motor is started, the slip is equal to 1 as the rotor speed is zero, so the induced emf in the rotor is large. As a result, a very high current flows through the rotor. This is similar to a transformer with the secondary coil short circuited, which causes the primary coil to draw a high current from the mains. Similarly, when an induction motor starts, a very high current is drawn by the stator, on the order of 5 to 9 times the full load current. This high current can damage the motor windings and because it causes heavy line voltage drop, other appliances connected to the same line may be affected by the voltage fluctuation. To avoid such effects, the starting current should be limited. A soft start starter is a device which limits the starting current by providing reduced voltage to the motor. Once the rotor speed increases, the full rated voltage is given to it.

**16. What Is A Rotor?**

**Answer :**

The rotor is the non-stationary part of a rotary electric motor or alternator, which rotates because the wires and magnetic field of the motor are arranged so that a torque is developed about the rotor's axis. In some designs, the rotor can act to serve as the motor's armature, across which the input voltage is supplied. The stationary part of an electric motor is the stator. A common problem is called cogging torque.

**17. What Is Commutator?**

**Answer :**

A commutator is an electrical switch that periodically reverses the current direction in an electric motor or electrical generator. A commutator is a common feature of direct current rotating machines. By reversing the current direction in the moving coil of a motor's armature, a steady rotating force (torque) is produced. Similarly, in a generator, reversing of the coil's connection to the external circuit produces unidirectional current in the circuit. The first commutator-type direct current machine was built by Hippolyte Pixii in 1832.

**18. What Is An Armature?**

**Answer :**

An armature is one of the two principal electrical components of an electromechanical machine--a motor or generator. The other is the field winding, field magnet. The role of the "field" component is simply to create a magnetic field (magnetic flux) for the armature to interact with, so this component can comprise either permanent magnets, or electromagnets formed by a conducting coil. The armature, in contrast, must carry current so it is always a conductor or a conductive coil, oriented normal to both the field and to the direction of motion, torque (rotating machine), or force (linear machine). The armature's role is two-fold: (a) to carry current crossing the field, thus creating shaft torque (in a rotating machine) or force (in a linear machine), and (b) to generate an electromotive force ("EMF").

# STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR

**Q1. The method which can be used for the speed control of induction motor from stator side is**

a. V / f control
b. Controlling number of stator poles to control $N_s$
c. Adding rheostats in stator circuit
d. All of these

ANSWER: d. All of these

**Q2. The consequent pole method used for controlling the number of poles can be used for**

a. Only squirrel cage type motors
b. Only slip ring induction motor
c. For both squirrel cage and slip ring induction motor
d. None of these

ANSWER: a. Only squirrel cage type motors

**Q3. The best suited method for smooth speed control by controlling number of poles is**

a. Consequent poles method
b. Multiple stator winding method
c. Pole amplitude modulation method
d. None of these

ANSWER: c. Pole amplitude modulation method

**Q4. In pole amplitude modulation method for controlling number of poles, practically, the wave used for modulation is**

a. Square wave
b. Triangular wave
c. Saw tooth wave
d. Sinusoidal wave

ANSWER: a. Square wave

**Q5. In cumulatively cascade method for speed controlling, if $P_A$ is the number of poles of main motor and $P_B$ is the number of poles of auxiliary method. Then the speed of the rotor B is given by**

a. $120f / P_A + P_B$
b. $120f / P_A - P_B$
c. $120f / P_A$
d. $120f / P_B$

ANSWER: a. $120f / P_A + P_B$

**Q6. In cascade control method, the set cannot be operated if**
a. $P_A > P_B$
b. $P_A < P_B$
c. $P_A = P_B$
d. None of these

ANSWER: c. $P_A = P_B$
**Q7. Kramer system for controlling the speed of 3 phase induction motor is mostly used for motors of**
a. Above 4000 kW
b. Below 4000 kW
c. Below 3000 kW
d. None of these

ANSWER: a. Above 4000 kW
**Q8. The disadvantages of scherbius system used for speed controlling in 3 phase induction motor is**
a. It cannot be used for slip ring induction motors
b. It cannot be used for squirrel cage induction motors
c. It can be used for large induction motors
d. None of these

ANSWER: b. It cannot be used for squirrel cage induction motors
**Q9. While using stator resistance starter with 3 phase induction motor, the resistances of the starter are kept at**
a. Maximum
b. Minimum
c. Half of the maximum value
d. None of these

ANSWER: a. Maximum
**Q10. When stator resistances are starter is used, the factor by which stator voltage reduces is say x. If x<1, then due to stator resistance starter, the starting torque**
a. Increases by fraction x
b. Reduces by fraction x ∧ 2
c. Reduces by fraction x
d. Increases by fraction x ∧ 2

ANSWER: b. Reduces by fraction x ∧ 2
**Q11. An autotransformer starter is suitable for**
a. Star connected induction motor
b. Delta connected induction motor
c. Both (a) & (b)

d. None of these

ANSWER: c. Both (a) & (b)

**Q12. The cheapest starter for induction motor is**

a. Stator resistance starter
b. Autotransformer starter
c. Star-delta starter
d. Rotor resistance starter

ANSWER: c. Star-delta starter

**Q13. Windings of star-delta starter while starting and during running are connected in**

a. Star, delta
b. Delta, delta
c. Star, star
d. Delta, star

ANSWER: a. Star, delta

**Q14. The advantages of star-delta starter over other types of starter is**

a. Cheapest of all
b. Maintenance free
c. Both (a) & (b)
d. None of these

ANSWER: c. Both (a) & (b)

**Q15. When rotor resistance starter is used with induction motor then**

a. Only starting current is limited
b. Only starting torque is limited
c. Both starting current and starting torque are limited
d. Neither starting current nor starting torque is limited

ANSWER: c. Both starting current and starting torque are limited

**Q16. Direct online starter also called D.O.L. starter is used for motors having capacity**

a. Less than 5 h.p.
b. Less than 10 h.p.
c. Greater than 10 h.p.
d. For any capacity motor

ANSWER: a. Less than 5 h.p.

**Q17. The NO contact and NC contact of D.O.L. starter is normally**

a. Open, closed
b. Closed, open
c. Open, open

d. Closed, closed

ANSWER: a. Open, closed

**Q18. A 3 phase induction motor in a short circuit current is equal 3 times of the full load current. If the full load slip is 2%, then the starting torque as a percentage of full load torque is**

a. 6% of full load torque
b. 18% of full load torque
c. 36% of full load torque
d. None of these

ANSWER: b. 18% of full load torque

**Q19. In textile machines, to avoid breaking of threads, soft starters are used. The commonly used method in soft starter is**

a. Direct online method
b. Star-delta method
c. Thyristor voltage controller method
d. Thyristor current controller method

ANSWER: c. Thyristor voltage controller method

## SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES

**Q1: Where do we require single-phase induction motors?**

Ans: Single-phase induction motors are required where
(i) 3 phase supply is not available
(ii) efficiency is of lesser importance
(iii) Rating is less than one H.P.
(iv) Equipment is portable

**Q2: Why is the power factor of a single-phase induction motor low?**

Ans: It is due to the large magnetizing current which ranges from 60% to 70% of full-load current. As a result, even at no-load, these motors reach temperatures close to the full-load temperature.

**Q3: What is the function of centrifugal starting switch in a single-phase induction motor?**

Ans: The centrifugal switch is connected in series with the starting winding. The primary function of the centrifugal switch is to produce rotating flux in conjunction with main winding at the time of starting. When the motor has started and reaches nearly 75% of synchronous speed, it produces its own rotating field from the cross field effect. The starting winding now has no function to perform and is removed from the circuit by a centrifugally operated switch.

**Q4: What happens when the centrifugal starting switch fails to open?**
Ans: If the starting switch fails to open when needed, then the starting winding will overheat and burn out and motor will not start next time.

**Q5: What happens when the centrifugal switch fails to close when needed?**
Ans: If the centrifugal starting switch fails to close, the motor will overheat the main winding without any failure of the main winding.

**Q6: Why are resistance split-phase inductions motors most popular?**
Ans: These motors are most popular due to their low cost. They are used where moderate starting torque is required and where the starting periods are not frequent. They drive fans, pumps, washing machines, small machine tools etc. They have power ranting between 60 watts and 250 watts.

**Q7: What is the draw back of the resistance split-phase induction motor?**
Ans: The starting winding has a relatively small number of turns of fine wire and its resistance is higher than that of the main winding. Therefore the current density is high and the winding heats up quickly. If the starting period lasts for more than 5 seconds, the winding begins to smoke and may burn out unless the motor is protected by a built-in-thermal relay.

**Q8: Why is the starting torque of a resistance split-phase induction motor not high?**
Ans: The starting torque is given as, $Ts = K\ Im\ Is\ Sin\ \Phi$
Where
K = constant whose magnitude depends upon the design of the motor
(i) The angle between Is and Im is small (approximately 25 degree) in a resistance split-phase induction motor, so the starting torque is small.
(ii) Since currents Is and Im are not equal in magnitude, the rotating magnetic field is not uniform and the starting torque produced is small.

**Q9: Why is the starting torque of a capacitor start induction motor high?**
Ans: The capacitor C in the starting winding is so chosen that Is leads Im by 75 degree. Since the starting torque is directly proportional to Sin Φ, and it is quite high in capacitor-start induction motor.

**Q10: Why do we use capacitor-start induction motors in applications requiring high starting torque in preference to repulsion induction motors?**
Ans: Capacitors are easily available, cheaper and reliable. Repulsion-induction motors posses a special commutator and brushes that require maintenance. Most manufacturers have stopped making them.

**Q11: What is the principle of operation of shaded-pole induction motor?**

Ans: A shaded-pole motor is basically a small single-phase squirrel cage motor in which the starting winding is composed of short-circuited copper ring (called shading coil) surrounding one-third of each pole. The effect of the shading coil is to cause a flux to sweep across the pole faces, from unshaded to shaded portion of the pole, producing a weak rotating magnetic field. As a result, the rotor is set in motion due to induction principle.

**Q12: Which type of torque is developed in single phase motors?**

Ans: Pulsating torque is produced.

Q13: If a single phase motor is driven in any direction by any means, it starts running in that direction. Explain why?

Ans: Actually a pulsating torque has two components which are equal in magnitude and rotate in opposite direction with synchronous speed at unity slip. Now if the motor rotates in any direction, the slip decreases and the torque component in this direction increases than the other component and hence motor runs in that direction.

**Q14: What is a fractional H.P. motor?**

Ans: A small motor having H.P. less than unit is called fractional H.P. motor.

**Q15: Which type of rotor is used in single phase motors?**

Ans: Squirrel cage type

**Q16: How the starting winding produce rotation in a single phase resistance start induction motor?**

Ans: The starting winding is highly resistive and the main winding is inductive. So the phase difference between the two currents becomes nearly 90 degree and hence the motor start as two phase motor.

**Q17: How the starting winding is made resistive?**

Ans: It consists of only few turns of smaller diameter.

**Q18: How the speed of rotation of a split phase induction motor is reversed?**

Ans: The terminal connections of the starting windings are reversed with respect to main running windings.

**Q19: What will happen if the centrifugal switch fails to open the starting winding?**

Ans: Excessive heat will be produced due to high resistance of the starting winding due to which stator temperature will rise and eventually both windings will burn.

**Q20: How speed control is made in single phase motors?**

Ans: It is usually controlled by applying a variable voltage from tapped transformers, variacs, potentio meters, and tapped reactors.

**Q21: Is there any relation between the capacitances of two capacitors used in two value capacitor motor?**
Ans: Starting capacitor has about 10 – 15 times high capacity than the value of running capacitor.

**Q22: What is size of shaded-pole motor?**
Ans: These are usually built in small fractional H.P, not exceed 1/4 H.P.

**Q23: Why shaded-pole single phase induction motor does not need any special starting technique like capacitors and auxiliary winding etc.**
Ans: Because it is inherently self started motor. The construction of the poles is such that they give a sweep to the magnetic flux and motor starts rotating.

**Q24: How can a universal motor be reversed?**
Ans: By reversing either the field leads or armature leads but not both.

**Q25: What are applications of Stepper motors?**
Ans: (i) Paper feed motors in typewriters and printers
(ii) Positioning of print heads
(iii) Pens in XY-plotters
(iv) Recording heads in computer disc drives etc.

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