

GCUF

Subject : Electrical Machines 2

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Question # 1

Write Introduction, Advantages, disadvantages & Construction of Three Phase Induction Motor.

Ans:-

Introduction,

These motors are popular because of their simple and robust construction and high reliability factor even in the sea environment. It can be used for different applications with various speed and load requirements. They run at essentially constant speed from no-load to full load. Speed is frequency dependent and consequently these motors are not easily adapted to speed control. We prefer d.c. motors when large speed variations are required. Like any electrical motor, a 3-phase induction motor has a stator and a rotor. Stator carries 3-phase winding (called stator winding). ^{only} Stator ^{winding} is fed from 3-phase supply. Rotor carries a short-circuited winding (called rotor winding).

Motor winding derives its voltage and power from externally energized stator winding through electromagnetic induction and hence the name. It may be considered to be transformer with rotating secondary and it can, therefore, be described as a "transformer type" a.c. machine in which electrical energy is converted into mechanical energy. These motors are simple, rugged, low-priced, easy to maintain and can be manufactured with characteristics to suit most industrial requirements.

Advantages:

- i) It has simple and rugged construction.
- ii) It is relatively cheap.
- iii) It requires little maintenance.
- iv) It has high efficiency and reasonably good power factor.
- v) It has self-starting torque.

Disadvantages:

- i) It is essentially a constant speed motor and its speed cannot be changed easily.

ii) Its starting torque is inferior to d.c. Shunt motor.

Construction:-

Almost 80% of mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating characteristics, absence of commutator and good speed regulation. Induction motors are also called asynchronous motors as it runs at a speed other than the synchronous speed. It has two major part like any motor have i.e. stator and rotor which is separated by air-gap ranges from 0.4 mm to 4mm, depending on power of motor.

It consists of:-

- i) Shaft for transmitting the torque to load. This shaft is made up of steel.
- ii) Bearings for supporting the rotating shaft.
- iii) One of problems with electrical motor is the production of heat.

during its rotation, it is overcome by using fan for cooling.

iv) For receiving external electrical connection Terminal box is needed.

v) There is a small distance between rotor and stator which usually varies from 0.4 to 4 mm. Such distance is called over air gap.

Question #2

Write operating principle (working) of three phase induction motor.

Ans:- Unlike toys and flash lights, homes, factories and other buildings aren't powered by little batteries but with ac current, which reverse its direction about 50 times per second (50 Hz). To run this motor at ac, we need a different design. In an AC motor, there's a ring of electromagnetic st arranged around the outside (making up the

Stator), which are designed to produce a rotating magnetic field. Inside the stator, there is a solid metal core, loop of wire, a coil, a squirrel cage made of metal bars and interconnections, or some other metal parts that can conduct electricity. Unlike DC motor, where power is sent to rotor. In AC motors power is sent to stator. These stator's coils are energized in pairs, in sequence, producing a magnetic field that rotates around the outside of motor. The magnetic field is constantly changing (because it's rotating) so, according to laws of electromagnetism (Faraday's law) the magnetic field induced an electrical current inside rotor. If conductor is a ring or a wire, current flows around it in a loop. If conductor is simply a solid metal, eddy currents swirl around it. The induced current produces its own magnetic field and according to another law of electromagnetism (Lenz's law), its magnetic field tries

to stop the magnetic field that causes that current to eliminate the difference in Electromagnetic induction is the key to why a motor like this spins. That's why it's called an induction motor.

They are classified as Synchronous, Single and three phase induction and special purpose motors. Out of all types, three phase induction motors are most widely used for industrial applications.

The operating principle of a three phase induction motor is based on production of rotating magnetic field.

Question # 3

Discuss different types of starter for three phase Induction Motor.

- i) Direct On-line starter (DOL)
- ii) Star-Delta Starter
- iii) Auto Transformer Starter
- iv) Rotor Impedance Starter

Answer:-

- i) Direct On-line Starter (DOL):-

It

is used for small (below 5KW) ^{max three} phase induction motors. The starting current would be very large, usually 5 to 7 times the rated current. The starting torque is likely to be 1.5 to 2.5 times the full load torque. DOL starter is used to start an induction motor directly. It consists of a contactor and a motor protection equipment (like, circuit breaker). Contactor is controlled by start and stop push button. When start push button is pressed, the contactor gets energized and it closes all the three phases of motor to supply phases at a time. The stop push button de-energizes the contactor and disconnects all the three phases to stop the motor.

ii) Star-Delta Starter:-

This method is used for motors, which are designed to run on delta connected stator. A two way switch is used to

Connect the stator winding in star while starting and in delta while running at normal speed. When the stator winding is star connected, voltage over each phase in motor will be reduced by a factor $\frac{1}{\sqrt{3}}$ of that would be for delta connected winding. The starting torque will $\frac{1}{3}$ times that it will be for delta connected winding. Hence a star-delta starter is equivalent to an auto-transformer of ratio $\frac{1}{\sqrt{3}}$ or 58% reduced voltage.

iii) Auto-transformer starter:

Auto-transformers are also known as auto-starters. They can be used for both star or delta connected squirrel cage motors. It is a three phase step down transformer with different taps provided that permit the user to start motor at say 50%, 65% or 80% of line voltage. At starting, switch is at "start" position, and a reduced voltage

(which is selected using a tap) is applied across the stator, when the motor gathers an appropriate speed, say upto 80% of its rated speed, the auto-transformer automatically gets disconnected from the circuit as switch goes to "Run" position.

iv)

Rotor Impedance Starter:-

This method allows external resistance to be connected to the rotor through slip ring and brushes. Initially, the rotor resistance is set to maximum and is then gradually decreased as the motor speed increases, until it becomes zero.

The rotor impedance starting mechanism is usually very bulky and expensive when compared with other methods. It also has very high maintenance cost. Also, a considerable amount of heat is generated through the resistors when current runs through them. The starting frequency is

also limited in this method. However, the rotor impedance method allows the motor to be started while on load.