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Assignment Electrical Machines
4 (2-2)

Submitt to Sir Farhan Khalid

Q No:1

Write induction, Advantages, disadvantage and construction of three phase induction moter.

- A 3-phase induction motor is a machine which is constructed to work on the 3-phase supply.
- The three-ϕ induction motor is also known as the asynchronous. Its working is depending on the principle of the revolving magnetic field
- There are two main types of this motor first one is wound rotor motor and 2nd is Squirrel cage rotor.
- This motor works at a constent speed in case of no load or full load conditions

Advantages.

- Induction motor are simple and rugged in construction
- Induction motor are cheaper in cost due to the absence of brushes, commutators and slip rings.
- They are maintainance free motors unlike dc motors and synchronous motors due to the absence

of brushes, commutators and slip rings.

- Induction motor can be operated in polluted and explosive environments.
- 3 phase induction motors will be self starting torque unlike synchronous motors hence no starting method are employed unlike synchronous motor

Disadvantages.

- 3-phase induction motor have poor starting torque and high have in rush currents. Therefore there motors are not widely used for application which require high starting torque like traction systems. Squirrel cage induction motor have poor starting torque. Starting torque in case of slip ring induction motor is comparitively better because of the presence of external resistor in the motor circuit during starting.
- Induction motor always operate under lagging power factor and during light load condition they operate at very worst power factor (0.2 to 0.4 lagging). Some of the disadvantages of power an increase in I^2R losses in the

System, induction in the efficiency of the system. Hence some power factor correction equipments such as static capacitor banks should be placed near to these motor to deliver the reactive power to them.

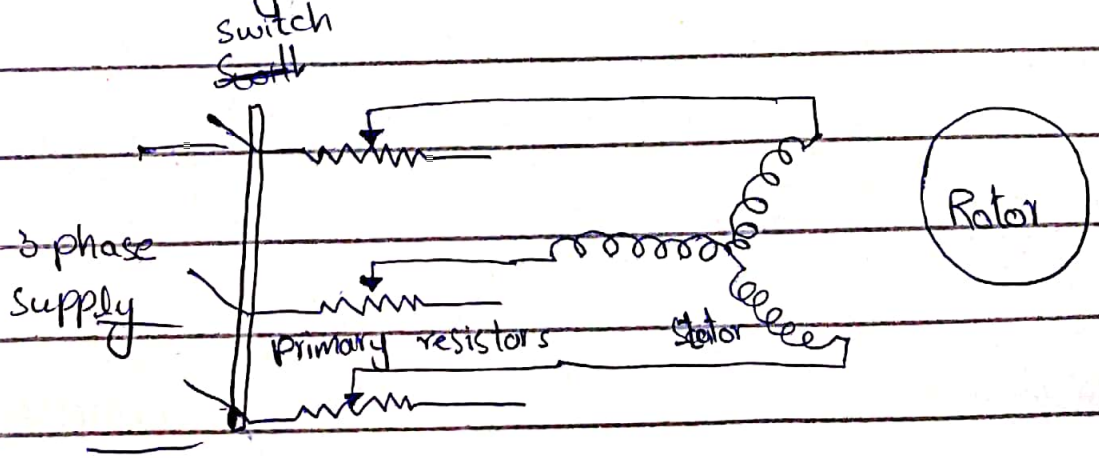
- One of the main disadvantage of 3-phase induction motors is that speed controls of induction motors are difficult.

Construction.

The main body of the induction motor comprises of two major parts

Stator.

The stator is made up of number of stampings in which different slots are cut to recive 3-phase winding circuit which is connected to 3phase AC supply.



The three phase windings are arranged in such a manner in the slots that they produce a rotating magnetic field after AC supply.
usually windings are kept at different pitch circle with 30% over lap to each other.
The windings are wound for a definate no. of poles depending upon the speed requirement, as speed is inversely proportional to the no. of poles.

$N_s = 120 F/P$

where N_s = Synchronous Speed.

F = Freqency

P = no. of poles

Rotor.

The rotor consist of a cylindrical laminated core with parallel slots that conductors bars. Conductors are heavy copper or aluminium bars which fit in each slot. These conductors are brazed to the short-circuiting end rings. The slots are not exactly made parallel to the axis of the shaft but are slotted a little skewed for following reasons.

They reduce magnetic hum or noise
They avoid stalling of the motor.

Principle.

when 3-phase supply is given to the motor, the resulting current generates a magnetic flux "ϕ". Due to the switching sequence of 3-phase current in R, Y, and B, the generated flux rotates around the rotor conductor According to the Faraday's law, which states that, "an emf induced in way closed circuit is due to the rate of change of magnetic flux through the circuit". Emf induced in the copper bar and due to this current flows in the rotors. The direction of the rotor can be given by lenz law which states that "the direction of induced current will be in opposite of the motion causing it"

Hence the relative velocity b/w the rotating flux and static motor conductor is cause of current generation, the rotor will ~~operate~~ rotate in same direction to reduce cause i.e. the relative velocity rotating the rotor of induction rotor.

Q No:2

Write operation principal (working) of three phase induction motor.

- when the motor is excited with three phase supply, three phase motor stator winding produce a rotating magnetic field with 120 displacement at constent magnetude which rotates at synderonous speed. This changing magnetic field cuts the rotor conductor and induce a current in them accoding to the principle of faraday's laws of electromagnetic induction. As there rotor conductors are shorted, the currents starts to flows through these conductors.
- In the pressence of magnetic field, of stator, rotor conductors are placed, and therefore, accoding to the Lorenz force principle, a mechanical force acts as the rotor conductor. Thus, all the rotor conductors force, i.e, the sum of the mechanical force produces torque in the rotor which tends to move it in the same direction of rotating magnetic field.
- This rotor conductor rotation can also be explained

by Lenz's law which tells that induced currents in the rotor oppose the cause for its production, here this opposition is rotating magnetic field this resulted the rotor starts rotating in the same direction of stator rotating magnetic field. If the rotor speed more than stator speed, then no current will induce in the rotor because the reason for rotor rotation is the relative speed of the rotor and stator magnetic field. This stator and the rotor fields difference is called as slip. This how 3-phase motor is called as a synchronous machine due to this relative speed difference b/w the stator and the rotors.

- As we discussed above, the relative speed b/w the stator field and rotor conductors causes to rotate the rotor in particular direction. Hence, for producing the rotation, the rotor speed Nr must always be less than the stator field speed Ns, and the difference b/w these two parameters depends on the load on the motor.

The difference of speed or the slip of the AC induction motor is given as

Formula, $s = \frac{n_s - n_r}{n_s}$

The slip may also be expressed as percent slip as follows:

$$\text{Percent slip} = \frac{n_s - n_r}{n_s} \times 100$$

At other speeds, the rotor frequency is proportional to the slip (s): that is,

$F_r = sF$

where f_r frequency of motor currents

- when the stator is stationary, Nr=0; so the slip becomes 1 or 100 %.
- when Nr is at synchronous speed, the slip becomes zero; so the motor never runs at synchronous speed.
- The speed slip in the 3 phase induction motor from no load to full load is about 0.1 % to 3 %; that's why the induction motors are called constant speed motors.

Q No:3

Discuss different types of starter for three phase induction motor.

i)

Direct on-line starter (DOL)

The DOL starter basically consist of two main protection part

- over current protection
- overLoad protection

An electromagnetically operated contactor is used which can be operid by thermal overload relay whenever a fault condition occurs.

• over current protection.

when the amount of current larger than the rated current of the device passed through the system such devices operates and open the circuit until the fault is removed from the system. we can also say that when a little higher amount of current beyond the rating of motor pass overload protection starts operating and prevent the mechine from any hazard. If the

over load current presists for a long span of time then things and machines get damaged overload protection doesn't trip even if a high value of current flows for a short span of time such as the starting of the motor over current protection rating is alway slected with so much care that it must provide enough protection against high current and also it must allow enough current without operating the over current protection for the motor to operate under heavy mechanical load.

- **overload protection.**

whenever motor draws too much amount of current to fulfill the load damand and if load demand goes beyond the allowable limit, such condition or situation is called as overload. An electric over load occure when an excessive amount of current pass through electric wires or from motor windings. The wires or windings can heat and melt, with the risk of starting a fire. Therefore, over load protection is used in it. It is basically a type of safety

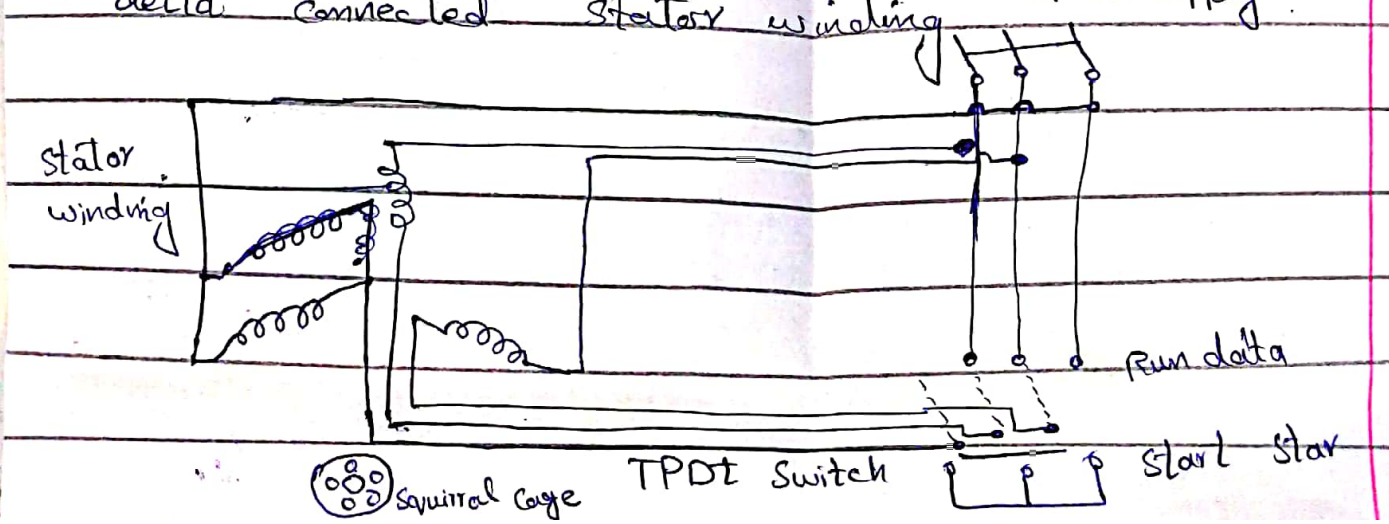
protection when the motors draws too much current or overload current and causing the overheating of the electrical machine. ~~so that's~~

ii

Star-Delta Starter

A Star Delta is the most commonly used method for the starting of a 3-phase induction motor. on star delta starting an induction motor is connected is through a star connection through out the starting period. Now once the motor reaches the required speed, the motor is connected in through a delta connection.

A star delta starter will start a motor with a star connected stator winding. when motor reaches about 80% of its full load speed, it will full load speed, it will begin to run in a delta connected stator winding.

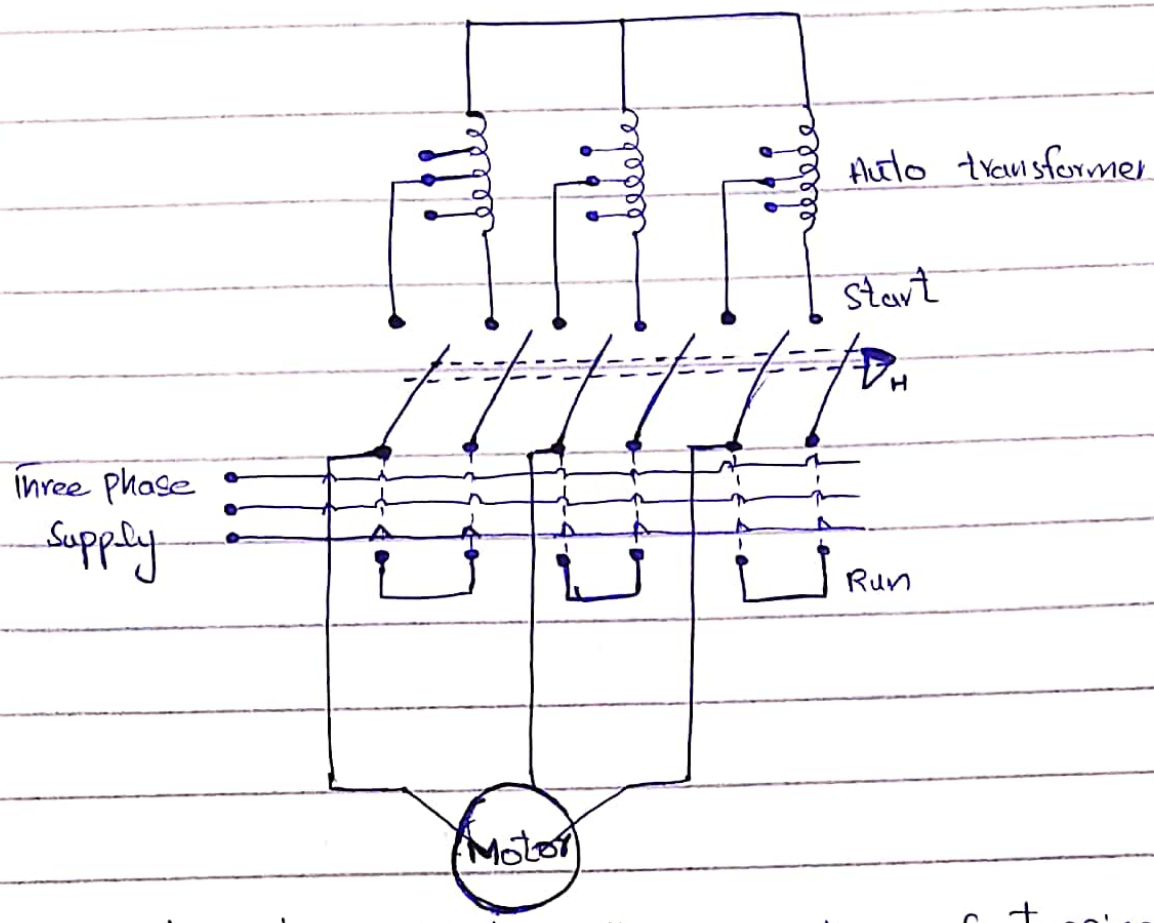


The starter mainly consist of a TPDP switch which stand for triple pole double throw switch. This switch changes stator winding from star to delta. During starting condition stator winding is connected in the form of a star. Now we shall see how a star delta starter reduces the starting current of a three-phase induction motor

iii

Auto transformer starter.

Auto transformer starter is suitable for both star and delta connected motors. In this method, the starting current is limited by using a three-phase auto transformer to reduce the initial stator applied voltage. The figure below shows the motor with the auto transformer starter.

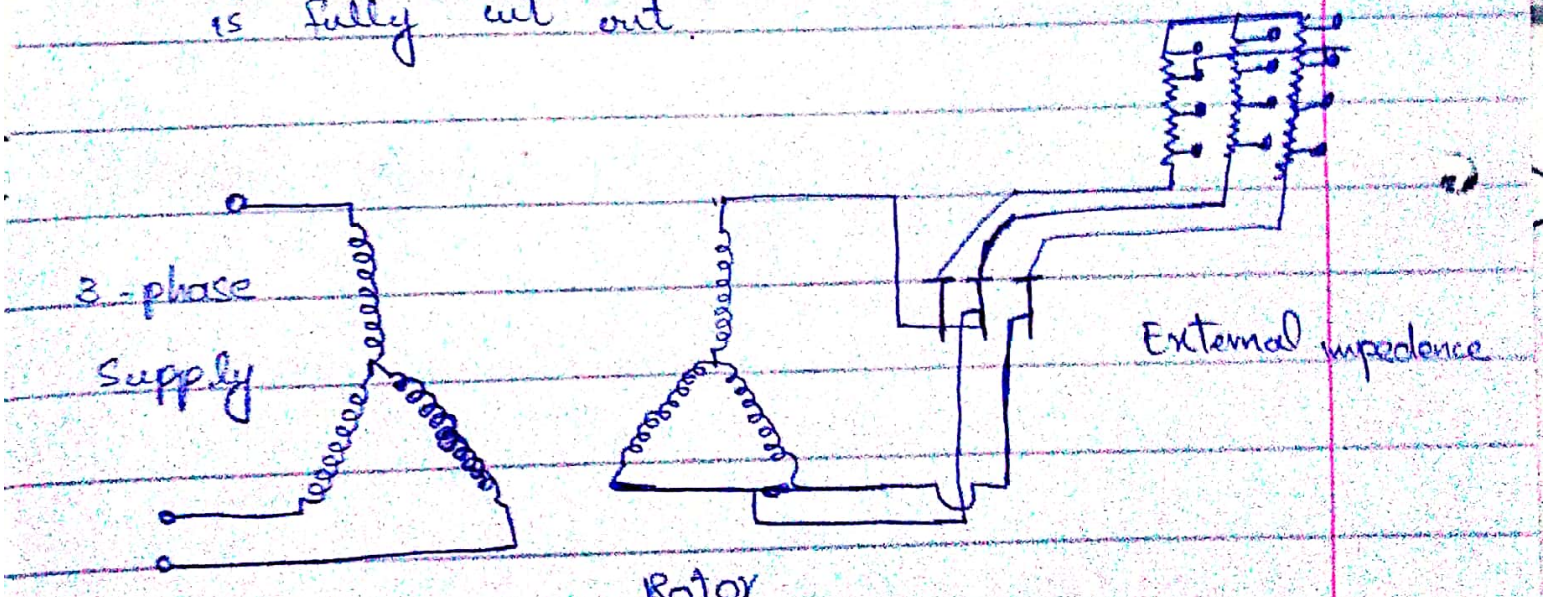


It is provided with a number of tappings. The starter is connected to one particular tapping to obtain the most suitable starting voltage. A double throw switch S is used to connect the auto transformer in the circuit for starting. when the handle H of the switch S in the start position. The primary of the auto transformer is connected to the supply line, and the motor is connected to the secondary of the auto transformer.

iv)

Rotor impedence starter.

- The easiest methode of starting wound rotor induction motors is to connect some extra impedence in the rotor circuit.
- Connection of extra impedence in the rotor circuit decrease the starting current and at the same time increase the starting torque.
- As the motors starts rotating the extra impedence is gradually cut out
when the motor attains rated speed the impedence is fully cut out.



when the motor attains rated speed the resistance is fully cut out and slip ring terminal are short circuited. The motor now operates on its characteristics which gives