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## **Assignment 2**

Q1) (a) Write a short note on power stages of an induction motor and torque developed by induction motor? Discuss the relation of torque, mechanical power and rotor output?(6)

(b) The power input to the rotor of 440V, 50Hz, 6 pole, 3-phase, induction motor is 80KW. The rotor electromotive force is observed to make 100 complete alterations per minute. Calculate (1) the slip, (2) the rotor speed, (3) rotor copper loss per phase?(4)

Q2) Short question answers?(5)

(1) How changes in supply voltage and frequency do affect the performance of induction motor?

(2) What factors determine the direction of rotation of the motor?

(3) What is meant by single phasing and what are its causes?

(4) How can motors be protected against single phasing?

(5) What are the indications of winding faults in an induction motor?

Q3) Make 15 slides presentation on assigned topic of AC machines?(5)

**Q1) (a)** Write a short note on power stages of an induction motor and torque developed by induction motor? Discuss the relation of torque, mechanical power and rotor output?(6)

**ANS:**

### **Power Stages in an Induction Motor:**

Different stages of power development in an induction motor

- Stator iron loss (consisting of eddy and hysteresis losses) depends on the supply frequency and the flux density in the iron core. It is practically constant.
- The iron loss of the rotor is, however, negligible because frequency of rotor currents under normal running conditions is always small. Total rotor Cu loss =  $3 I_2^2 R_2$ .
- An induction motor develops gross torque  $T_g$  due to gross rotor output  $P_m$ .

### **Torque produced:**

An induction motor develops torque by inducing current to the rotor, which is proportional to the differential speed of the rotor and the rotating magnetic field in the stator.

Torque in a 3-phase induction motor is created by the interaction between the rotating magnetic field produced by the alternating current in the stator windings and the magnetic field produced by the induced current in the rotor assembly. ... The two fields interact, producing torque.

### **Relationship of torque**

The developed torque or Induced Torque Equation in a machine is defined as the Torque generated by the electric to mechanical power conversion. The torque is also known as electromagnetic torque This developed torque in the motor differs from the actual torque available at the terminals of the motor, which is almost equal to the friction and wind age torques on the machine.

### **QUES 1(b):**

**(b)**The power input to the rotor of 440V, 50Hz, 6 pole,3-phase,induction motor is 80KW.The rotor electromotive force is observed to make 100 complete alterations per minute. Calculate(1) the slip, (2) the rotor speed,(3) rotor copper loss per phase?(4)

## Solution:

(i)

$$100 \text{ alterations/minute} = \frac{100}{60} \text{ cycles/sec}$$

$$1.6667 \text{ Hz} = sf$$

$$\text{Hence, the slip, } s = \frac{1.6667}{50} = 0.03333 \text{ P.u. or } 3.333\%$$

$$(ii) \text{ rotor speed, } N = (1 - s) N_s = (1 - 0.03333) \times 1000$$

$$\text{Since } N_s = \frac{120}{6} \times 50 = 1000 \text{ rpm, } N = 966.67 \text{ rpm}$$

$$(iii) \text{ rotor copper losses/phase} = \frac{1}{3} (\text{s. rotor input})$$

$$\text{total rotor power input} = 80 \text{ kW}$$

$$\text{rotor power input per phase} = 80/3 \text{ kW}$$

$$\text{rotor copper losses per phase} =$$

$$\frac{0.0333}{3} \times 80 = 0.8888 \text{ kW}$$

## QUES2 shorts notes:

(1) How changes in supply voltage and frequency do affects the performance of induction motor?

ANS:

High voltage decreases both power factor and slip, but increases torque. Low voltage does just the opposite. Increase in frequency increases power factor but decreases the torque. However, per cent slip remains unchanged Decrease in frequency decreases power factor but increases torque leaving per cent slip unaffected as before.

(2) What factors determine the direction of rotation of the motor?

**ANS:**

The phase sequence of the supply lines and the order in which these lines are connected to the stator winding.

(3) What is meant by single phasing and what are its causes?

**ANS:**

Single phasing is a power supply-related electrical fault in case of an induction motor. It occurs when one of the 3 phase circuits in a three-phase motor is opened; hence the remaining circuits carry excess current.

**CAUSES:**

Single phasing is a power supply-related electrical fault in case of an induction motor. It occurs when one of the 3 phase circuits in a three-phase motor is opened; hence the remaining circuits carry excess current. This condition of Single Phasing is usually caused when:-

\* One or more out of the three back up fuse blows (or fuse wire melts if the fuse is of wire type

\* The motor circuit has contactors which supply the current. One of the contactors is open circuited.

(4) How can motors be protected against single phasing?

**ANS:**

Such a condition requires that the motor is provided with protection that will disconnect it from the system before the motor is permanently damaged. All motors above 500 KW are to be provided with protection devices or equipment to prevent any damage due to single phasing.

(5) What are the indications of winding faults in an induction motor?

**ANS:**

**INDICATION:**

- excessive current drawn by motor
- over-heating of stator frame at particular spot
- smell of burning
- jerky operation motor
- motor may not start
- motor not able to provide full load torque
- imbalance current drawn by motor

Fault can be observed with the help of digital millimeter