**Handout**

**Subject Name: Electrical Machines-II**

**Prepared by : B. Susmitha, Asst.Professor EEE**

**Year and Sem, Department: II Year II Sem, EEE**

**Unit-I: (Poly-Phase Induction Machines)**

**Important points / Definitions:**

* The working of three phase induction motors is based on the principle of rotating magnetic field.
* The rotating magnetic field can be defined as the field or flux having constant amplitude but whose axis is continuously rotating in a plane with a certain speed.
* The important features of three phase induction motors are self starting, higher power factor, good speed regulation and robust construction.
* The direction of the R.M.F. is always from the axis of the leading phase of the three phase winding towards the lagging phase of the winding.
* The speed of this rotation magnetic field is synchronous speed Nsr.p.m. 
* The difference between the two speeds i.e. synchronous speed of R.M.F. ( Ns ) and rotor speed (N) is called slip speed.
* Slip of the induction motor is defined as the difference between the synchronous speed ( Ns) and actual speed of rotor i.e. motor (N) expressed as a friction of the synchronous speed ( Ns ).
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* At start, motor is at rest and hence its speed N is zero.



* Practically motor operates in the slip range of 0.01 to 0.05 i.e. 1 % to 5 %. The slip corresponding to full load speed of th motor is called full load slip.

**Short Questions (Minimum 10 previous JNTUH Questions – Year to be mentioned)**

1. What is slip and slip speed of an Induction motor?[ Apr-2018]
2. Give the applications of 3-phase induction motor. [Apr-2018]
3. List any two differences between cage rotor and wound rotor. [Dec-2018]
4. Explain the concept of RMF. [Dec-2018]
5. What is rotating magnetic field of a three phase induction motor. [May-2019]
6. Define slip of an induction motor. Write the equation for the same. [May-2019]
7. Write the merits and demerits of slip-ring induction motor.[Apr-2017]
8. Why the rotor slots of a 3-phase induction motor are skewed?
9. State the difference between slip ring rotor and cage rotor of an induction motor?
10. Write an expression for the slip of an induction motor.

**Long Questions (Minimum 10 previous JNTUH Questions – Year to be mentioned)**

1. Explain the R.M.F production in an 3-phase Induction motor. [Apr-2018]

1. A 3-phase induction motor is wound for 4 poles and is supplied from 50 Hz system. Calculate (i) the speed at which magnetic field of the stator is rotating. (ii) the rotor speed when slip is 4% and (iii) the frequency of the rotor currents when the slip is 0.03 and (iv) the frequency of the rotor currents when at stand still. [Apr-2018]
2. Explain the working of 3-phase Induction motor. Compare the constructional features of both squirrel cage induction motor and slip ring induction motor. Discuss the merits of one over the other. [Apr-2018]
3. Describe the principle of operation of three phase induction motor. Explain why the rotor is forced to rotate in the direction of rotating magnetic field? [Dec-2018]
4. Show that the voltage generated in the rotor circuit of a three phase induction motor at any slip s is equal to s times the voltage generated at standstill? [Dec-2018]
5. Discuss the points of similarities and dissimilarities between a transformer and an induction motor. Hence, explain why an induction machine is called a generalized transformer? ? [Dec-2018]
6. Explain why three phase induction motor, at no load operates at very low power factor? [Dec-2018]
7. Define i) Synchronous speed, ii) Actual speed of an induction motor. [May-2019]
8. A three phase, 400V, 100hp, 50Hz, 4-pole induction machine delivers rated output power at a slip of 5%. Determine the i) synchronous speed ii) motor speed (actual speed) iii) frequency of the rotor induced voltage.[May-2019]
9. 12 pole, 3 phase alternator driven at a speed of 500rpm supplies power to an 8pole, 3phase induction motor. If the slip of the motor at full load is 0.03, calculate the full load speed of the motor.[May-2019]
10. The active power input to a 415V, 50Hz, 6 pole 3-phase Induction motor running at 970rpm is 41kW. The input power factor is 0.9. Calculate line current and slip.[May-2019]
11. With the help of neat diagram explain the constructional features of wound rotor type of induction motor. Write any one advantage and dis- advantage of wound rotor type of induction motor. [May-2019]
12. Obtain the relation between rotor input, rotor copper losses and rotor output in terms of slip(s).[Apr-2017]

**Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)**

1. The frequency of the induced emf in an induction motor is **Same as the supply frequency**
2. Slip ring induction motor has  **High starting torque**
3. The frequency of rotor current in an induction motor is **slip times the frequency of supply**
4. Slip of an induction motor increases with  **increase in current and torque**
5. In an induction motor, rotor speed is always **Less than the stator speed**
6. Slip ring induction motor are employed only for **High starting torque**
7. The advantage of skewing in induction motor is / are **More uniform torque is obtained while running**
8. In induction motor, greater the number of poles **Lesser the speed**
9. Starting torque increases with increase in value of rotor **resistance.**
10. Since the rotor has very low resistance, the copper loss is low and efficiency is **high**

**Unit-II: (Characteristics of Induction Machines)**

**Important points / Definitions:**

* So if stator supply voltage is known and ratio of stator to rotor turns per phase is known then the rotor induced e.m.f. on standstill can be obtained.
* The starting torque Tst as,



* The slip at which the torque is maximum and is denoted as sm.

               sm= R2/X2

* Magnitude of Maximum Torque is
* 
* Full load and Maximum Torque Ratio is  TF.L./Tm= (2 sfsm)/(sm2+ sf2)
* Starting Torque and Maximum Torque Ratio is 
* Relation between p2,pc,pm is 

**Short Questions (Minimum 10 previous JNTUH Questions – Year to be mentioned)**

1. What is crawling in Three-phase Induction motor? [Apr-2018]
2. What is the principle of V/f speed control in Induction motor? [Apr-2018]
3. Draw torque – slip characteristic of three phase IM. [Dec-2018]
4. What is cogging? Explain? [Dec-2018]
5. What is cogging of an induction motor?[May-2019]
6. List three different speed control methods of a three phase induction motor.[May-2019]
7. Write the effects of crawling and cogging on the performance of induction motor.[Apr-2017]
8. What is the procedure to conduct the blocked rotor test on 3-ϕ induction motor?[Apr-2017]
9. Why starting methods are needed for 3-ϕ induction motor.[Apr-2017]
10. Derive the condition for maximum torque under running conditions in a 3-ϕ I.M.[May-2019]
11. Explain the speed control of 3-ɸ IM using cascade connection.[May-2019]
12. Explain the working principle of Induction generator.[May-2019]

**Long Questions (Minimum 10 previous JNTUH Questions – Year to be mentioned)**

1. Sketch and explain torque-slip characteristic of an induction motor working at rated Voltage and frequency.[Apr-2018]
2. No load test determines which parameters of the circuit model of induction motor? Explain in detail.[Apr-2018]
3. Explain the speed control of 3-phase Induction motor by cascade connection.[Apr-2018]
4. A 6 pole, 50 Hz, 3 phase induction motor running on full load with 3% slip develops a torque of 160 N-m at its pulley rim. The friction and windage losses are 210W and the stator copper and iron losses equal 1640W. Calculate (i) Rotor output (ii) Rotor copper loss (iii) Efficiency at full load.[Apr-2018]
5. Explain the principle of speed control of a 3-phase induction motor by V/f method and draw the corresponding torque-speed characteristics and discuss the applications and limitations of these methods.[Dec-2018]
6. A three phase, 400 V, 50 Hz induction motor takes a power input of 34 kW at its full load speed of 980 rpm. The total stator losses are 1.2 kW and the friction and windage losses are 1.5 kW. Calculate (i) slip (ii) rotor ohmic losses (iii) shaft power (iv) shaft torque and (v) efficiency.[Dec-2018]
7. Draw and explain the equivalent circuit of three phases IM.[Dec-2018]
8. A 3-phase, 400 V, 50 Hz induction motor has a rotor resistance of 0.1 Ω and standstill reactance of 0.9 Ω per phase. The full load slip is 4%, Calculate (i) Full load torque as a percentage of maximum torque and the value of extra resistance to be added in the rotor circuit to have 70% of maximum torque at start.[Dec-2018]
9. Why starters are necessary for starting an induction motor? What are the various types of starters used for Induction motor starting?[May-2019]
10. Explain with the aid of diagrams the principal of operation of double cage induction motor. Sketch the torque –slip curves of such a motor.[Apr-2017]
11. Explain the conducting procedure of No load test on three phase induction motor.[May-2019]

**Fill in the Blanks / Choose the Best: (Minimum 10 to 15 with Answers)**

1.A 3-phase 440 V, 50 Hz induction motor has a 4% slip. The frequency of the rotor current will be **2Hz**

#### 2. The efficiency of an induction motor is about 80-90%

3. The starting torque of a squirrel-cage induction motor is **Low**

4.A double squirrel-cage induction motor has **Two parallel winding in the rotor**

5.The term ‘Cogging’ is associated with **Induction motor**

6. A 50 Hz, 3-phase induction motor has a full load speed of 1440 r.p.m. The number of poles in the motor **is 4 pole**

7. A three phase, 50 Hz induction motor has a full load speed of 1440 rpm. The full load slip will be **4%**

8. The crawling in the induction motor is caused by **Harmonic developed in the motor**

9. An induction Motor is **self-starting with low torque**

10. If an induction motor with certain ratio of rotor to stator slots, runs at 1/7 of the normal speed, the phenomenon will be termed as **Crawling**