

Birla Institute of Technology & Science

Ist Semester 2016-17

EEE /INSTR F211 Electrical Machine

1. For how many poles in a 3 phase induction motor wound, if its rated supply frequency and rated speed are 50 Hz and 460 rpm, respectively? **[12]**
2. The rated supply frequency and speed of a three phase induction motor are 25 Hz and 720 rpm, respectively. If the speed at no load is 745 rpm, calculate (a) the full load slip and (b) the percentage speed regulation. **[(a)0.04; (b)3.47%]**
3. Most commercially available three phase induction motors have a full load slip of 0.05 or less. The measured speed of 60 Hz motor at rated load given to be 575 rpm.
 - a. How many poles does the motor have? **[12]**
 - b. What is the full load slip? **[0.0416]**
 - c. If the no load slip is 0.01, what is the percentage speed regulation? **[3.3%]**
 - d. What is the rotor frequency at no load, full load, and instant of starting? **[0.6Hz,2.5Hz,60Hz]**
4. A 3 phase, 4 pole wound rotor induction motor rated to operate on a 230V, 60Hz supply, has a star connected 3 phase winding on a stator and rotor. Each rotor phase has half the number of winding turns as the stator. If the rotor is rotating at 1725 rpm for a certain application, (assuming the stator voltage drops to be negligible) obtain-
 - a. The slip at the given operating condition. **[0.0417]**
 - b. The per phase voltage on the rotor with the rotor blocked. **[66.4V]**
 - c. The per phase voltage on the rotor at the given operating condition. **[2.77V]**
 - d. The frequency of rotor voltages at the given operating condition. **[2.5Hz]**
5. A three phase, 6 pole induction motor, rated to work on a 230V, 60Hz supply has 3 phase windings on the stator and the rotor. The stator winding are connected in delta, while the rotor windings are connected in star. Each winding on the rotor has 75% the number of turns as on each stator winding. The rotor windings are accessible through slip rings and brushes. With rated voltage applied to the stator, calculate the voltage (assuming all stator voltage drops to be negligible) and the frequency at the rotor slip rings with
 - a. The rotor at rest **[298.77V, 60Hz]**
 - b. The rotor operating at a slip of 0.04. **[11.95V, 2.4Hz]**

The rotor being forced to run by another machine at 800 rpm, in a direction reverse to the stator field. **[497.95V, 100Hz]**

6. A 400 hp, 2.3 kV, 60 Hz, 6 pole, 3 phase, Y-connected induction motor draws a line current of 25 A and a total power of 15 kW when operated with no external shaft load. The per phase values of stator resistance, rotor resistance and total series reactance are 0.42 ohms, 0.23 ohms, 1.9 ohms respectively; when all the quantities are referred to stator side. Assuming a friction and windage loss of 10 kW, and using the approximate equivalent circuit, compute the following quantities for the condition when the motor operates at rated output power:
- The slip and speed. [0.0145 amp, 1183 rpm]
 - The rotor phase current, referred to the stator. [81.1A]
 - The stator line current and power factor. [85.3A, 0.956 lagging]
 - Total developed torque. [2480 Nm]
 - Efficiency. [91.7%]
7. A 20 hp, 60 Hz, three phase induction motor has a rated speed of 1723 rpm. If the friction and windage losses amount to 5% of the output power, determine the rotor copper losses for rated operation. [700W]
8. A three phase, 220V, 60 Hz induction motors operated at free run. For an input voltage of 220V, the input power is 380W; while for an input of 40V, the corresponding figure is 90W. Obtain the friction and windage losses (assumed constant) and core losses for rated operation. [80W, 300W]
9. A three phase squirrel cage induction motor is rated for 15 hp, 1745 rpm, 220V, 60 Hz, 44.1 A, 0.757 pf lag; and is found to output maximum possible torque at a speed of 1365 rpm when supplied with rated voltage. If the rotational losses are known to be 335W, estimate its maximum possible values for gross torque and output power. [253.07Nm, 49.87 hp]
10. The wound rotor of a certain three phase induction motor has a blocked rotor inductive reactance of 0.412 ohm and a rotor resistance of 0.103 ohm. It is required to connect a star connected bank of external resistance to the rotor slip rings, so as to ensure that the motor always start within the stable operating region. What is the per phase value of external resistance required, if the motor is expected to start at
- Maximum possible starting torque? [0.309ohm]
 - Same starting torque, as available without any external rotor resistance? [1.545 ohm]
11. The supply connected to the stator of a three phase induction motor feeds 29kW at 50 Hz, of which 25kW is transferred to the rotor, the rotor copper loss amounts to 2.9kW, and 21kW is obtained as output power. The stator iron loss for this machine can be assumed to remain constant at 1.3kW.
- Find the frequency of the rotor electrical quantities. [5.8 Hz]
 - If the load always operates at the same speed, obtain the motor efficiency when operating at the rated voltage(as given above), half the rated voltage, and quarter of the rated voltage. [72.43%, 61%, 15.5%]