Sheet (2)

EMIV CECE 437
2016-2017

① A 220 V, Three-phase, two-pole, 50 Hz induction motor is running at a slip of 5 percent. Calculate

(a) The speed of the magnetic field in rpm.
(b) The speed of the rotor in rpm.
(c) The slip speed of the rotor.
(d) The rotor frequency in Hz

answer
(a) 3000 rpm
(b) 2850 rpm
(c) 150 rpm
(d) 2.5 Hz

② A 480 V, Three-phase, four-pole, 60-Hz induction motor running at a slip of 0.035.

(a) The speed of the magnetic field in rps
(b) The speed of the rotor in rps.
(c) The slip speed of the rotor in rps.
(d) The rotor freqeuency in Hz

answer
(a) 30 rps
(b) 28.95 rps
(c) 1.05 rps
(d) 2.1 Hz

③ A Three-phase, 60-Hz Induction motor runs at 1200 rpm sychronous speed and 1150 rpm rotor speed at full Load.

(a) How many poles does this motor have?
(b) What is the slip at rated Load?
(c) What is the slip speed of the rotor.

answer
(a) 6 poles
(b) 0.042 = 4.2%.
(c) 50 rpm

④ In the case of an 8-pole Induction motor, the supply frequency was 50 Hz and the shaft speed was 735 rpm. Calculate:

(a) Synchronous speed.
(b) Slip speed.
(c) motor slip.

answer
(a) 750 rpm
(b) 15 rpm
(c) 0.02 = 2%

⑤ A 6-pole, 50 Hz squirrel-cage induction motor runs on load at a shaft speed of 970 rpm. Calculate:

(a) The percentage slip.
(b) The frequency of the induced current in the rotor

answer
(a)
(b)

⑥ A 3-phase, 50 Hz induction motor with its rotor Y-connected gives 500 V (rms) at standstill between the slip rings on open-circuit. Calculate the current and power factor at standstill when the rotor winding is joined to Y-connected external circuit, each phase of which has a resistance of 10 Ω and an inductance of 0.04 H. The resistance per phase of the rotor winding is 0.2 Ω and its inductance is 0.04 H.

Also calculate the current and power factor when the slip-rings are short-circuited and the motor is running with a slip of 5%. Assume the flux to remain constant.

Problem (6):
Ans: 10.6A - 0.376 - 20.9A - 0.303

⑦ A 1100 V, 50 Hz Δ-connected induction motor has a Y-connected slip-ring rotor with a phase transformation ratio of 3-8. The rotor resistance and standstill leakage reactance are 0.012 Ω and 0.25 Ω per phase respectively. determine:

(a) The rotor current at start with slip-rings shorted.
(b) The rotor power factor at start with slip rings shorted.
(c) The rotor current at 4% slip with slip rings shorted.
(d) The rotor power factor at 4% slip with slip rings shorted

[Hint: Transformation Ratio = stator to rotor turns ratio]

answer
(a) 1156.5 A
(b) 0.0478 lag
(c) 741.3 A
(d) 0.768 lag

(8) Obtain an expression for the condition of maximum torque of an induction motor. Sketch the torque-slip curves for several values of rotor circuit resistance and indicate the condition for maximum torque to be obtained at starting.

(9) What are the factors that affect on the synchronous speed of the induction motor?

(10) For a certain induction motor is connected to supply of 50 Hz. Calculate the speed of the stator field when the number of stator poles is: 2, 4, 6, 8, and 10. [answer: 3000 rpm - 1500 rpm - 1000 rpm - 750 rpm - 600 rpm]

(11) Why the speed of the 3-phase induction motor is named as "synchronous speed"?

(12) In practice, what happened if the rotor speed reachs the speed of the stator field of induction motor?

(13) What is meant by: slip - slip speed - synchronous speed?

(14) A 3-phase induction motor has a synchronous speed of 1000 rpm. standstill rotor resistance, rotor reactance, rotor induced e.m.f per phase are R_2, X_2 and E_2 respectively. If the relative speed is 40 rpm, what are the new values of: rotor resistance/phase, rotor reactance/phase, induced e.m.f/phase? [answer: $R_{2(new)} = R_2$, $X_{2(new)} = 0.04X_2$, $E_{2(new)} = 0.04E_2$]

(15) Without using external circuit: the motor p.f at standstill is better than the p.f of the motor at running condition with a slip 5%. or not? (indicate you answer using equations). [answer: p.f (s=5%) > p.f (s=1 standstill)]

(16) Deduce the starting torque equation in the induction motor?

(17) Deduce the Max. starting torque equation of the induction motor?

(18) For maximum starting torque: what is the value of the motor p.f? [answer: $\cos 45° = 0.77$ lag]

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