Kafrelsheikh University
Faculty of Engineering

Final Exam of 1st semester-2020-2021
Department of Electrical Engineering

Subject: **Electrical Machine3 (I.M.)** course code: EPM4116 Full Mark: 100 Marks
Year: Fourth Electrical Power (R.2007) Number of pages: 2 Time allowed: 3 hours
Exam Date: 15/3/2021

This exam measure the following ILOS (a.4,13,14 b.11,12,14,15, c.3,16,17, and d.1,2)
Please, answer all of them; assume any missing data; manage your time.

Q1 [20 Marks]

a) Why the rotor of an induction motor is skewed? [7 Marks]

b) A 10 H.P. 3-phase induction motor with full load efficiency and p.f. of 0·83 and 0·8 respectively has a short circuit current of 3.5 times full load current. Estimate the line current at the instant of starting the motor from a 500 V supply by means of star delta starter.. [13 Marks]

Q2 [15 Marks]

a) Why an induction motor is considered similar to a transformer? [5 Marks]

b) A 4 pole, 3-phase, 50 Hz, 400 V induction motor has a delta connected stator and a star connected rotor. Each phase of rotor winding carries one-fourth of the number of turns on each phase of stator winding. The full load speed is 1455 rpm The rotor resistance is 0.3 ohm, and rotor standstill reactance is 1 ohm per phase. The stator and rotor windings are similar. Stator losses equal 100 W. Friction and windage losses are equal to 50 W. Calculate.

(*i*) blocked rotor voltage per phase (*ii*) rotor current per phase at full load
(*iii*) total rotor power input at full load (*iv*) rotor power loss at full load
(*v*) efficiency. [10 Marks]

Q3 [20 Marks]

a) Why the rotor conductors are placed at the outermost periphery of the rotor? [5 Marks]

b) 400 V, 3-phase, 50 Hz, 6 pole induction motor is supplying a load of 20 kW, when the frequency of rotor currents is 2Hz. Estimate (*i*) Slip and speed at this load (*ii*) Rotor copper loss (*iii*) Speed of motor when supplying 30 kW load assuming torque-slip curve to be a straight line. [15 Marks]

Q4 [15 Marks]

a) What is the effect of load on the efficiency of an induction motor? [5 Marks]

b) A 3- phase 4-pole, 50 Hz, 400 V, 8 kW, star connected squirrel cage induction has the following data:

$R_1 = 0.4\ \Omega$/phase; $R_2 = 0.25\ \Omega$ /phase; $X_1 = X_{2S} = 0.5\ \Omega$ /phase; $X_m = 15.5\ \Omega$ / phase. The motor develops full-load internal torque at a slip of 4%.

Assume that the shunt branch is connected across the supply, determine (*i*) slip at maximum torque, (*ii*) maximum torque developed at rated voltage and frequency (*iii*) torque developed at the start at rated voltage and frequency.

[10 Marks]

Q5 (20 Marks)

a) What are the various losses in an induction motor? On what factors do they depend? [5 Marks]

b) With the help of a circle diagram determine (i) starting torque, (ii) maximum torque, (iii) maximum output (iv) slip for maximum torque and (v) maximum output For a 200 V, 50 Hz, 3-phase, 7.46 kW, slip ring induction motor with a star-connected stator and rotor. The winding ratio of the motor is unity, whereas the stator and rotor resistance per phase is 0.38 and 0.24 Ω, respectively. The following are the test results:

No-load test: 200 V, 7.7 A, 874 W

Blocked-rotor test: 100 V, 39.36 A, 3743 W. [15 Marks]

Q6 (10 Marks)

In wounded rotor induction motor design, how you can calculate the following: the number of rotor turns, the rotor current, cross section area, magnetizing current, Dispersion Coefficient. What is the effect of dispersion coefficient on induction motor characteristics [15 Marks]

With my best wishes
Associate prof./Mohamed I. Abd EL_Wanis