EN 206 – Power Electronics & Machines

Assignment on: INDUCTION MACHINE

1) A 400V, 4 Pole, 3 Phase, 50 Hz star connected induction motor has a rotor resistance and reactance / phase = 0.01Ω and 0.1Ω respectively. Determine i) Starting Torque ii) Slip at which maximum torque will occur. iii) Speed at which maximum torque occurs iv) The value of maximum torque v) Full load torque if full load slip is 4%. Assume ratio of stator to rotor turns as 4.

   (Ans. i) T_{st} = 63.031 N-m ii) s_m = 10% iii) N= 1350rpm iv) T_m=318.16 N-m v) T_{fl}= 219.52N-m)

2) a) Rotor resistance & standstill reactance / phase of a 3 phase induction motor are 0.04Ω and 0.2Ω respectively. What should be the external resistance required at starting in the rotor circuit to obtain: i) Maximum torque at start ii) 50% of maximum torque at start?

   (Ans. i) R_{ex} = 0.16 Ω / phase ii) R_{ex} = 0.0135 Ω / phase)

   b) A 3 phase, 4 pole, 50 Hz, star connected induction machine running on full load develops a useful torque of 300 N-M. The rotor emf is completing 120 cycles / minute. If the torque lost in friction is 50N-M, calculate i) slip ii) Net Pout iii) Rotor Cu loss phase iv) Rotor efficiency v) Rotor resistance/phase if rotor current = 60A in running condition.

   (Ans. i) s=0.04 ii) Pout = 45.2389 kW iii) Rotor Cu loss = 733.0378 W/ph. iv) η of rotor = 96% v) R_2 = 0.2036 Ω/phase)

3) a) The useful torque of a 3 phase, 50Hz, 8 Pole IM is 190N-M. The rotor frequency is 1.5Hz. Calculate the rotor cu loss if machine losses are 700W

   (Ans. P_C = 469.326 W)

   b) The full load power input to 4 pole, 50Hz, 3 phase IM is 50 kW, running at 1440rpm. Calculate the full load efficiency if stator losses are 1000W & frictional losses are 650W.

   (Ans. η = 92.78%)

   c) The power input to a 6 pole, 3 phase, 50 Hz IM is 41 kW. The total stator loss is 1 kW and total frictional & winding loss is 2 kW. The speed is 960 rpm. Find i) slip ii) BHP iii) Rotor Cu loss iv) efficiency.

   (Ans. & = 4%. BHP = 49.49 iii) P_C = 1.6 kW iv) η = 88.78 %)

4) While delivering an useful power of 24 kW to the full load a 3 phase, 50 Hz, 8 pole IM. draws a line current of 57A. It runs at a speed of 720rpm and is connected to 415V supply. The pf of the motor is observed to be 0.707 (lag) Stator resistance/phase = 0.1Ω. Mechanical losses are 1000W. Calculate i) shaft torque ii) gross torque iii) Rotor cu losses iv) Stator cu losses v) Stator iron losses vi) Overall efficiency. Assume star connected stator winding.

(Ans. i) T_{sh} = 318.309 N-m ii) 331.572 N-m iii) P_{Cu} = 1041.66 W iv) Stator cu loss = 974.7 W v) Stator iron loss = 1950.76 W & η = 82.85%)

5) A 500V, 3phase, star connected IM has a stator impedance of (0.062+90.21Ω) .The equivalent rotor impedance at standstill is same. The magnetizing current is 36A. The core loss is 1500W and mechanical loss is 750W. Find the output efficiency and power factor at slip of 2%. Use approximate equivalent circuit as shown in figure below:

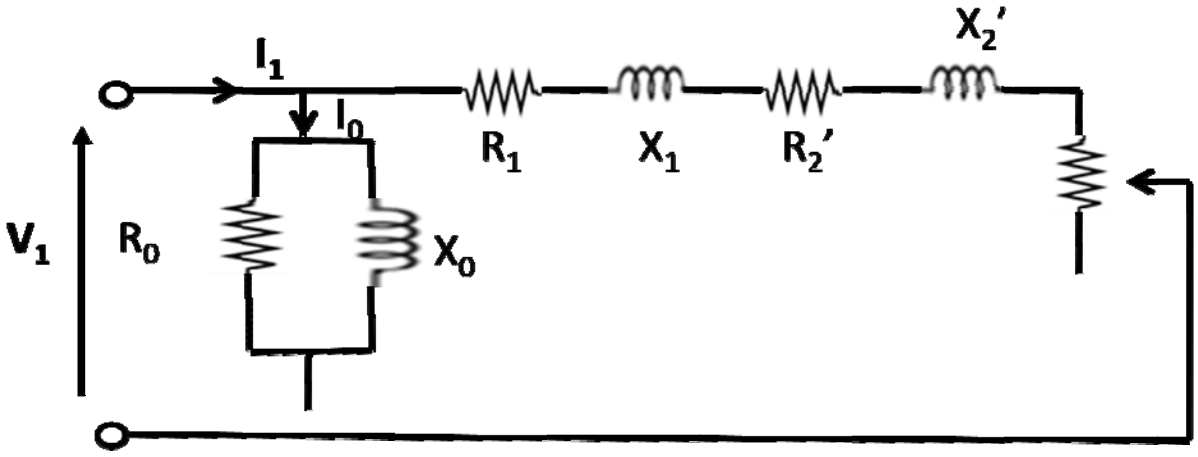


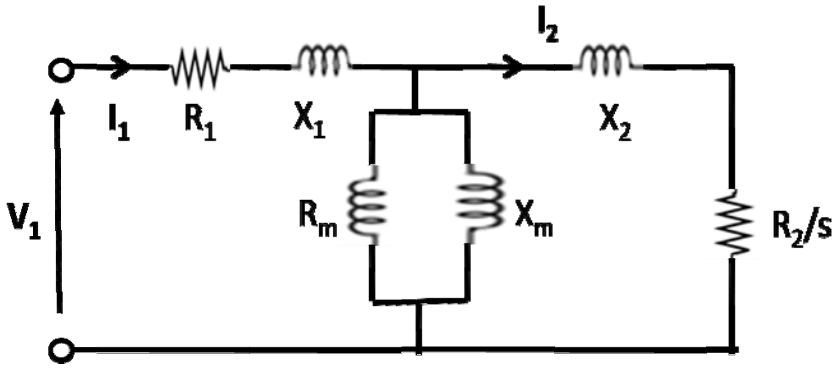
Figure: approximate circuit of IM question 5

(Ans. pf = 0.8857 lag, Pout = 73895.9385 W, η = 93.31%)

6) a) An IM has an efficiency of 0.9 when the load is 50HP. At this load, stator Cu loss and Rotor Cu loss is each equal to the iron loss. The mechanical losses are one-third of the no load losses. Calculate the slip.

(Ans. s = 3%)

7) A 50HP, 420V, 3phase, 10Pole, delta connected induction motor has r_1=0.19Ω, r_2=0.29Ω, x_1=x_2=1.12Ω, r_m=143Ω and X_m = 16.8Ω. Full load slip = 2.6%. Use exact equivalent circuit shown below:-



Calculate:

i) stator current

ii) Rotor Cu loss(total)

iii) Rotor input power

Figure: exact equivalent circuit of IM question 7

(Ans. i) I_1 = 45A, pf = 0.76(log) ii) Rotor Cu loss = 1014.07W iii) Rotor input = 39 kW)

8) A 6 pole, 3 phase, 50 Hz IM runs on full load with a slip of 4%. The motor standstill impedance / phase is (0.01+i 0.05) Ω. Calculate the available maximum torque in terms of full-load torque. Also determine the speed at which maximum torque occurs.

(Ans. T_m =2.6T_{fl} & N = 800 rpm, s_m=0.2)

Speed Control of IM

9) A 2.8 kW, 400V, 50Hz, 4 pole, 1370 rpm,delta connected squired cage IM has the following parameters referred to stator. R_s =2Ω, R_r'=5Ω, X_s=X_r' =5Ω, X_m =80Ω. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate i) motor terminal voltage, current and torque at 1200 rpm and ii) motor speed, current and torque for the terminal voltage of 300V.

(Ans. i) V = 253.2V, I_{line} =17.89A, T =36.9N-m ii) N = 1279 rpm, I_{line} = 16.88A, T = 41.94N-m)