Tutorial #5
(Electric Machine)

QN1 A 400V, 4-pole, 50Hz, 3 phase, 10 HP, Star connected induction motor has a full slip of 4%. Given that efficiency and power factor of the motor at full load are of 92% and 0.8 lag respectively. Calculate:

a) Synchronous Speed
b) Speed at Full load
c) Frequency of rotor current at Full load
d) Full load torque.
e) Full load stator current [1500 rpm, 1440 rpm, 2Hz, 49.47 N-m, 14.63A]

QN2 A 400V, 4-pole, 50Hz, 3 phase, star connected induction motor has the following parameters per phase referred to stator side.

$R_1 = 0.6$ ohm, $X_1 = 1.1$ ohm, $R_0 = 100$ ohm and $X_0 = 25$ ohm

The friction loss is 800 watts. The motor draw a current of 25amp at full load and corresponding slip is 3% and input power factor is 0.85 lagging. Calculate:

a) Full load speed
b) Net shaft torque developed
c) Efficiency [1455 rpm, 76.46N-m, 84%]

QN3 A 400V, 4-pole, 50Hz, 3 phase, slip ring induction motor has a delta connected stator winding and a star connected rotor winding. At standstill the voltage between the two slip rings is 190V. The stator impedance is 0.5 + j2.5 ohm. The rotor resistance and reactance at standstill are 0.06 ohm and 0.3 ohm respectively and it develops a maximum torque of 150 N-m. Calculate:

a) Slip at which the motor develops the maximum torque.
b) Torque, power output at full load, given that full load slip is 0.04.

[0.2 pu, 57.69N-m, 11.66 hp]

QN5 A 150 kW, 3000V, 50Hz, 6 pole star-connected induction motor has a star-connected slip ring rotor with a transformation ratio of 3.6 (stator to rotor). The rotor resistance is 0.1 ohm/phase and rotor inductance is 3.61 mH per phase. Neglecting the stator impedance, calculate:

a) Starting current and torque on rated voltage with slip rings short circuited.
b) Necessary external resistance to reduce the rated voltage starting current to 30A and corresponding starting torque.

[a) 117.4 A, 513.1 N-m b) 4.21 ohm, 1440 N-m]

QN6 The power input to a 3-phase induction motor is 50kW and the corresponding stator losses are 2kW. Calculate (a) Power developed by rotor and rotor copper loss when the slip is 3%. (b) Output horse power of the motor if the friction and windage losses are 1 kW and (c) efficiency of the motor. (46.56KW, 1.44KW, 45.56 kW, 91.12%)

QN7 A 4 pole, 3-phase, 50Hz slip-ring type induction motor rotates at 1440 rpm with the slip-ring terminals short circuited. The per phase rotor resistance and reactance are 0.1 ohm and 0.6 ohm respectively at standstill. If an extra external resistance of 0.1 ohm per phase is added to the rotor circuit, what will be the new full-load speed? [1380 rpm]

QN8 A three-phase, 4 pole, induction motor has rotor resistance of 0.04 ohm per phase. The maximum torque occurs at 1200 rpm. Calculate the starting torque as a percentage of maximum torque. [38.4 %]

QN9 The power input to a 500V, 50Hz, 6-pole, 3-phase induction motor running at 975 rpm is 40 kW. The stator losses are 1 kW and friction loss is 2 kW. Calculate: (a) slip (b) Rotor copper loss (c) Output HP (d) Efficiency. [0.025, 975W, 48.98 HP, 90.06 %]

QN10 An 8-pole, 50Hz, 3-phase induction motor develops a maximum torque of 150 N-m at 650 rpm. The rotor resistance is 0.5 ohm per phase. Find the torque at 4 % slip. Neglect the stator impedance. [82.5 N-m]