Tutorial Week #6 to be submitted

Q1. A 220V, 3-phase, 4-pole, 50Hz, Y-connected induction motor is rated 3.73 kW. The equivalent parameters are:

$R_1 = 0.45\,\Omega$, $X_1 = 0.8\,\Omega$, $R_2' = 0.4\,\Omega$, $X_2' = 0.8\,\Omega$, $X_m = 30\,\Omega$; $R_m = 0$.

The stator core loss is 50W and rotational loss is 150W.

For a slip of 0.04, find

i) input current;
ii) pf;
iii) air-gap power;
iv) mechanical power
v) Torque
vi) output power
vii) Efficiency.

Use the exact equivalent circuit.

Ans: i) $12.7 \angle -25.8^\circ$ A
ii) 0.9
iii) 4152 W
iv) 3986 W
v) 26.4 N-m
vi) 3836 W
vii) 86.8%.

Q2. A 440V, 3-ϕ, 50Hz, 37.3kW, star connected induction motor has the following equivalent circuit parameters.

$R_1 = 0.1\Omega$, $X_1 = 0.4\Omega$, $R_2' = 0.15\Omega$, $X_2' = 0.44\Omega$.

Motor has core loss of 1250W, rotational loss of 1000W. It draws a no-load current of 20A at a p.f. of 0.09 (lag). When the motor operates at a slip of 3%, Calculate

i) input line current
ii) pf
iii) Developed torque
iv) output power
v) Efficiency of the motor.

Use approximate equivalent circuit.

Ans: $57.4 \angle -29^\circ$

0.875 (lag)

230 N-m

34,075 W

88.7%

Q3. The following test results are obtained from a 3-ϕ, 60hp, 2200V, 6-pole, Δ-conn. 50Hz, squirrel cage induction motor.

1) No-load test:

Line voltage = 2200V

Supply frequency = 50Hz.

Line current = 4.5A

Input power = 1600W

2) Blocked rotor test

Frequency = 15 Hz

Line voltage = 270 V

Line current = 25A

Input power = 9000 W.

3) Average dc resistance per phase is

$R_1 = 2.8\,\Omega$.

a) Determine the no-load rotational loss

b) Determine the equivalent circuit parameters of the motor.

Ans: 1429.9W

$R_2' = 2\,\Omega$, $x_1 = x_2' = 6.63\,\Omega$, $x_m = 27437\,\Omega$.

Q4. A three phase, 460V, 50Hz, 4-pole wound-rotor induction motor has the following parameters per phase:

$R_1 = 0.25\ \Omega$, $R_2' = 0.2\ \Omega$

$X_1 = X_2' = 0.5\ \Omega$, $X_m = 30\ \Omega$

The rotational losses are 1700 W. With the roter terminals short-circuited, find

a) i) Starting current when started direct on full voltage

ii) starting torque.

b) i) Full-load slip

ii) Full-load current

iii) Ratio of starting current to full load current

iv) Full-load power factor.

v) Full-load torque.

vi) Internal efficiency and motor efficiency at full-load.

c) i) Slip at which maximum torque is developed.

ii) Maximum torque developed.

d) How much external resistance per phase should be connected in the roter circuit so that maximum torque occurs at start?

Ans:

$245.9 \angle -66^\circ$ A

222.317 N-m

0.0333 — slip

$42.754 \angle -19.7^\circ$

5.75

0.94 (lag)

195.818 N-m

87.57.

0.1963

510.55 N-m

0.8186 Ω/ph.