Problem Sheet 4

Submission date: 31-03-2024

1.

(i) Find the efficiency of an induction motor operating at full load. The machine details are given in the following:

2000 hp, 2300 V, 3 phase, Star connected, 4 pole, 60 Hz, Full load slip = 0.03746

$R_s = 0.02\ \Omega$; $R_r = 0.12\ \Omega$; $R_c = 451.2\ \Omega$; $X_m = 50\ \Omega$; $X_{ls} = X_{lr} = 0.32\ \Omega$

(ii) The line power factor needs to be improved to unity by installing capacitors at the input terminals of the induction motor. Calculate the per-phase capacitance required to obtain a line power factor of unity.

2.

The no-load and locked-rotor test results for a three-phase, star-connected, 60-Hz, 2000-hp induction machine with a stator phase resistance of 0.02 Ω are as follows:

Test	Input line to line voltage, V	Line current, A	Three-phase input power, kW
No load	2300	26.55	11.617
Locked rotor	462.68	407.75	319.22

Obtain the equivalent circuit of IM.

3.

A 460-V, 25-hp, 60 Hz, four-pole, Y-connected induction motor has the following impedances in ohms per phase referred to the stator circuit:

$R_1 = 0.641\Omega$ $R_2 = 0.332\Omega$

$X_1 = 1.106\ \Omega$ $X_2 = 0.464\ \Omega$ $X_M = 26.3\ \Omega$

The total rotational losses are 1100 W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2.2 percent at the rated voltage and rated frequency, find the motor's

1. Speed
2. Stator current
3. Power factor
4. P_{conv} and P_{out}
5. τ_{ind} and τ_{load}
6. Efficiency