Massachusetts Institute of Technology

Department of Electrical Engineering and Computer Science

6.061/6.979 Introduction to Power Systems

Preview of Problem Set 10

Issued April 20, 2003
Due April 30, 2003

This problem set deals with a squirrel-cage induction motor with the following parameters:

Rated Output		100 kW	
Terminal Voltage	V_{ll}	480 V,	RMS, line-line
Number of Poles Pairs	p	2	(4-pole machine)
Supply frequency		60 Hz	
Armature Resistance	R_1	.0392 Ω	
Rotor Resistance	R_2	.0670 Ω	
Armature Leakage Inductance	X_1	.2480 Ω	
Rotor Leakage Inductance	X_2	.2480 Ω	
Magnetizing Inductance	X_ϕ	8.16 Ω	
Core Loss at rated voltage		1 kW	
Friction and windage loss at rated speed		2 kW	

Problem 1: Calculate and plot a torque-speed curve for this machine as a motor running with a power supply of rated voltage and frequency. In this part you should neglect windage but approximate the effects of core loss as a linear resistance.

Problem 2: Calculate and plot the magnitude of terminal current drawn as a function of speed.

Problem 3: What is 'breakdown' or maximum running torque for this motor with rated terminal voltage? What are the current and power factor when the motor is at breakdown?

Problem 4: In a test of this motor, the thing is run 'light', (without a mechanical load aside from friction and windage). If this test is carried out at rated terminal voltage, what are the real and reactive power drawn?

Problem 5 A similar test is called 'blocked rotor': the rotor of the machine is prevented from turning and the stator driven with a reduced voltage. What voltage should be used to result in a terminal current of 120 A, RMS? What are the real and reactive power drawn during such a test? What torque is produced?

Problem 5: For 6.979 Calculate and plot curves for efficiency and power factor vs. load power, from five to 100 percent of rated output power (5 kW to 100 kW). Can you teach MATLAB to operate the machine at a given output power?

Problem6: For 6.979 A common strategy for operating induction motors with adjustable speed drives is to use 'constant volts per Hz', or to make terminal voltage proportional to drive frequency, for frequencies less than *base* or rated frequency. Above rated frequency voltage is held constant. To see how this would work, plot a family of torque-speed curves for this motor operating with terminal frequencies of 10, 20, ... 100 Hz.