

ECE 3354 – Power Systems Laboratory

<p>Experiment MATLAB 208V Induction motor: Three Phase Induction Machines</p>
--

Date of Experiment

Month/Day/Year

Prepared By:

Author's Name

Partner's Name

Prepared For:

Instructor's Name

Objective

State what the purpose of the experiment is. Brief, and don't copy manual's words.

1. Derive a single phase equivalent circuit in Figure 1 for the tested machine. Assume a NEMA "D" motor. Set $R_1 = R_2$, and $X_1 = X_2$ in the equivalent circuit.

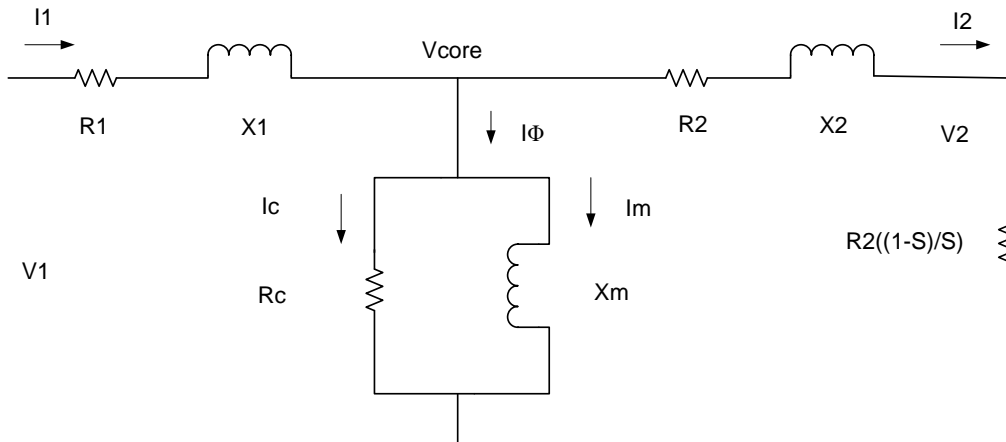


Figure 1

Experimental data:

Blocked-rotor test at rated line current (1.2A). Record I , V_{L-L} , $P_1 - \phi$. Note line to line voltage will be less than $30V_{L-N}$

V_{L-N}	V_{L-L} Calculated	I_{Line} Rated	P_{in} phase
		1.2A	

No-load test at rated voltage ($208V_{L-L}$). Record I , V_{L-L} , $P_1 - \phi$.

V_{L-N} Rated	V_{L-L} Calculated	I_{Line}	P_{in} phase
$120V_{L-N}$			

Induction motor full load test at rated current (1.2A).

V_{L-N} Rated	I_{Line} Rated	P_{in} phase	RPM	Torque
120V	1.2A			

Include schematic of model, calculate all values and show work. Find R_c , X_m , R_1 , X_1 , R_2 , X_2 , PF_{NL} , and PF_{BR} .

Remember: BOLD = Complex quantity, NON-BOLD = Magnitude quantity

$$SLIP = S = (SPEED_{syn} - SPEED_m) / SPEED_{syn}$$

$$P = T \omega$$

$$T = P/\omega$$

$$Q = \sqrt{S^2 - P^2}$$

$$pf = P/S$$

$$\mathbf{V}_{NL} = V_{NL} \angle 0^\circ \quad (\text{Complex})$$

$$\mathbf{I}_{NL} = I_{NL} \angle -\arccos(pf_{NL}) \quad (\text{Complex})$$

Blocked rotor test

$$R_{BR} = P_{BR} / I_{BR}^2$$

$$R_1 = R_2 = R_{BR} / 2$$

$$X_{BR} = Q_{BR} / I_{BR}^2$$

$$X_1 = X_2 = X_{BR} / 2$$

No load test

$$\mathbf{V}_{core} = \mathbf{V}_{NL} - \mathbf{Z}_1 * \mathbf{I}_{NL} \quad (\text{Complex})$$

$$P_{core} = P_{NL} - R_1 * (I_{NL})^2$$

$$Q_{core} = Q_{NL} - X_1 * (I_{NL})^2$$

$$R_c = |\mathbf{V}_{core}|^2 / P_{core} \quad \text{Parallel branch}$$

$$X_m = |\mathbf{V}_{core}|^2 / Q_{core} \quad \text{Parallel branch}$$

$$T_{dev} = 3 * I_2^2 * \left(R_2 * \left(\frac{1-s}{s} \right) \right) / \omega_m \quad \text{Total Torque developed function of Slip}$$

$$\mathbf{Z}_1 = R_1 + j X_1 \quad (\text{complex})$$

$$\mathbf{Z}_2(s) = R_2 + j X_2 + R_2((1-s)/s) \quad \text{Per phase function of Slip (complex)}$$

$$\mathbf{Z}_{core} = R_c || X_m \quad (\text{complex})$$

$$\mathbf{Z}_{motor}(s) = \mathbf{Z}_1 + \mathbf{Z}_{core} || \mathbf{Z}_2(s) \quad \text{Per phase function of Slip (complex)}$$

$$I_1(s) = V_1 / |\mathbf{Z}_{motor}(s)| \quad \text{Per phase function of Slip}$$

Note: If you calculated series core branch you must convert to parallel core branch.

2. Plot the output **torque vs. speed** and current **I₁ vs. speed** from the experiment data.
Note: Plot the three different voltage cases for torque on the same plot. Plot the three different voltage cases for current I₁ on the same plot. **Include plots, schematics.**
3. Write a matlab program using the equivalent circuit. You must use the equivalent circuit in figure 1, include all branches and components R₁, R₂, R_C, X_m, X₁, and X₂. Plot torque vs. speed in RPM curves and current vs. speed in RPM for 80%, 90% and 100% of rated voltage as speed varies from 1 to 1799 RPM. **Note:** Plot the three different voltage cases for output torque on the same plot. **Hint** use **figure** command to plot the three curves on the same plot. Plot the three different voltage cases for current on the same plot. Compare the calculated data with the measured data include MATLAB program listing and plot output. **Hint** the fluke meters in the lab measure the magnitude of voltage and current.

Include all plots and program listing.

4. Change the equivalent circuit by Increasing the resistor R₂ in the rotor by 2Ω, then 4Ω of the equivalent circuit and recalculate the curves as above. This new set of curves is equivalent to adding resistance to the rotor of the machine. **Note: Plots :** Plot at 100% rated voltage the three different R₂ cases for output torque on the same plot. Plot at 100% rated voltage the three different R₂ cases for the I₁ current on the same plot. **Hint** let R₂ = R₂: R₂ +2: R₂ + 4.

Include all plots and program listing unless the program above produced these plots.

5. Comment on the differences noted between using stator voltage control and adding rotor resistance, to control the speed of the motor. **Keep your answers short 5 lines or less.**

6. Explain why the induction motor slows down as the load is increased.
Keep your answers short 5 lines or less.

7. Explain how the three-phase induction motor develops starting torque.
Keep your answers short 5 lines or less.