ELEC 344 Lab Report 4

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5A-1)

R_1 and L_m can be found using the no load test where $S \sim 0$ and rotor circuit can be treated as open circuit.

Calculating R_1

$$P_{nl} = I_{rms} V_{rms} cos(\theta)$$
$$\boxed{R_1 = \frac{P_{nl}}{I_{rms}^2}/2 = 0.345/2 = 0.1725\Omega}$$

Calculating L_m

Assuming $L_m \gg L_{l1}$.

$$P(\text{Reactive Power}) = \sqrt{I_{rms}^2 V_{rms}^2 - P_{nl}^2} = \omega * L_{l1} * I_{rms}^2$$
$$\omega = 2\pi 60 Hz$$
$$\boxed{L_{lm} = 0.0086529H}$$

Calculating L_{l1}, L_{l2}, and R_2

L_{l1}, L_{l2}, and R_2 can be found using block motor test. Assuming the impedance of L_{l2} in series with R_2 is much smaller than the impedance of L_m.

$$\boxed{R_2 = \frac{P_{total}/3}{I_{rms}^2} = 0.2839\Omega}$$
$$(L_{l1} + L_{l2})\omega I_{rms}^2 = \sqrt{(V_{rms}^2 I_{rms}^2) - (P_{total}/3)^2}$$
$$\boxed{L_{l1} = L_{l2} = 0.000731913H}$$

Calculating Number of Poles

$$\text{motor rpm} = \frac{120 f_{in}}{p}$$
$$p = 120 * 60/1750 = 4.11 \sim 4$$

Calculating Power Factor

$$\omega_{synchronous} = 0.5 * 2 * \pi * 60 = 188.495 rad/s$$
$$\omega_{rotor} = 1750 rpm * 2\pi/60 = 183.259 rad/s$$
$$\omega_{slip} = 5.23598 rad/s$$
$$\theta = tan^{-1}(\frac{\omega_{slip} L_{l2}}{R_2}) = 0.77335°$$
$$cos(\theta) = 0.9999$$

5A-2

From Table-6, R_2 is estimated. Looking at the table, the first and the 4th measurements are outliers. The 2nd and 3rd give the best estimate of R_2 because the slip is smaller relative to the later measurements. The estimate is also really close the the resistance calculated in 5A-1.

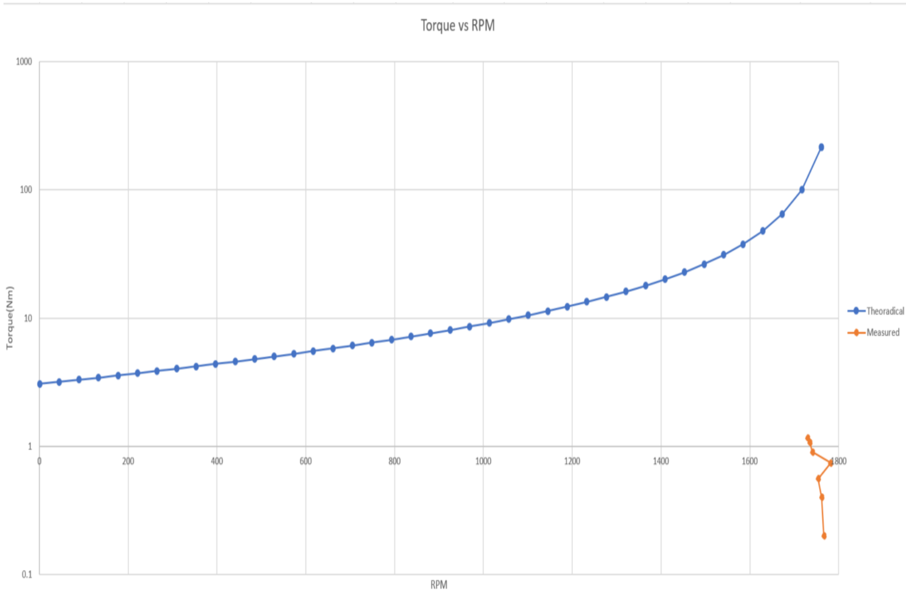
$$R_2 = 0.32\Omega$$

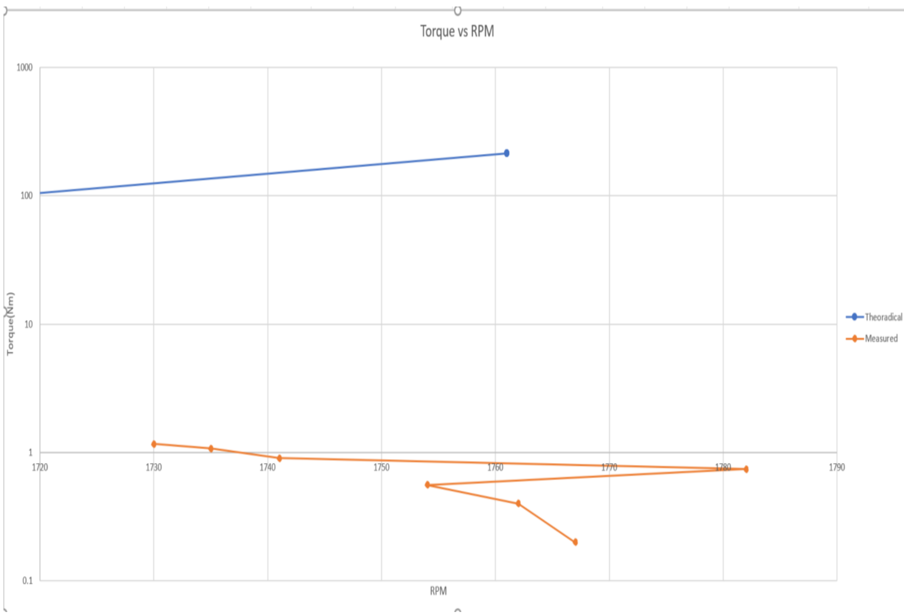
5B:Equivalent Circuit vs Measured Comparison

From the equivalent circuit, we found the Thevenin Equivalent treating the rotor circuit as load such that rotor current can be found.

Python script is used to calculate the Thevenin equivalent parameters.

$$V_{th} = 17.95788$$
$$Z_{th} = 0.14699 + 0.262784j$$
$$I_{rotor} = V_{th}/Z_{total}$$
$$Z_{total} = 0.14669 + R_{rotor}/s + (0.262784 + X_{l2})j$$
$$P_{em} = 3 * I_{rotor}^2 * R_{rotor} * (1 - s)/s$$
$$T_{em} = P_{em}/\omega_{rotor}$$





As shown in the graphs, the measured values starts to decrease just before the theoretical reaches the pull out torque and start decreasing. Ideally both graph should reach 0 torque at 1800 rpm since s will approach 0.