

Name:
Section:

ECE 431 Electric Machinery Spring 2020

Pre-lab assignment #5

Due at the beginning of your lab session – no late Pre-lab assignments accepted.

Read the experiment and be prepared for the procedure.

1. Why are some portions of the experiment conducted at 33% of rated voltage?

with reduced voltage, lower speed area of torque-speed curve can be explored while also complying the current limit.

2. Assume the following equivalent circuit parameters:

f [Hz]	Poles	V ₁ [V]	R ₁ [Ω]	L ₁ [mH]	R ₂ ' [Ω]	L ₂ ' [mH]	R _c [Ω]	L _m [mH]
60	2	230	1.41	3.69	1.27	5.53	668.7	149.8

a) What peak torque do you expect at rated voltage?

$$T_{max} = \frac{3P}{4\omega_e} \left[\frac{V_{TH}^2}{R_{TH} + \sqrt{R_{TH}^2 + (X_{TH} + X_2)^2}} \right] ; Z_{TH} = (R_1 + jX_1) // jX_m = 1.34 + 1.39j$$

$$V_{TH} = V_1 \cdot \left(\frac{jX_m}{R_1 + j(X_1 + X_m)} \right) = 129.56V \Rightarrow T_{max} = 13.18 \text{ Nm}$$

b) What current would be expected at peak torque given rated input voltage at 60 Hz?

$$I_{s_{maxT}} = \frac{R_2'}{\sqrt{R_{TH}^2 + (X_{TH} + X_2')^2}} = 0.341 \quad I_{max} = \frac{|V_{TH}|}{|Z_{TH} + jX_2' + R_2'/s_{maxT}|} = 22.42 \text{ A}$$

c) What current would be expected at peak torque given 33% of rated input voltage at 60 Hz?

$$I_{max} \propto V_{TH} \propto V_1 \Rightarrow I_{new} = 0.33 \times 22.42 = 7.47 \text{ A}$$

3. Find torque as a linear function of slip for the low-slip regime of the machine you tested in Experiment 4. Based on this:

a) What torque would you expect at rated voltage and frequency at a speed of 3640 RPM?

$$T_e \approx \frac{3|V_1|^2 s}{\omega_e (X_2')} \times \frac{P}{2} ; s = \frac{3600 - 3640}{3600} = -0.011 \Rightarrow T_e = -1.01 \text{ Nm}$$

b) What torque would you expect at 33% of rated voltage and 20 Hz input at a speed of 1160 RPM? Final answer may vary with value of r_2' used

$$s = 0.033, V = 0.33V_1 \Rightarrow T_e = 1.23 \text{ Nm}$$

Should be equal magnitude, opposite sign as 3(a)