ECE 522
Induction Machines
Fall Semester 2019
Midterm
Problems I, II, and III

EXAMINATION RULES

1 You are on your honor to do your own work on this examination. That is, you will neither give nor receive aid on this examination, except from the course instructor. If you violate this confidence, you will receive the grade of zero for this examination.

2 Please summarize your work at the end of each problem. Thank you!

3. Show all of your work! Make it neat. No partial credit will be given if I can not easily follow your work.

4. Submit your completed examination 48 hours after you receive it.

5. Please use "ECE 522 Exam 1" as the subject for the email that you use to return your work.

6. Attach a separate file for each problem. Please name them:
   LastName_FirstName_P1.what ever extension is appropiate
   LastName_FirstName_P2.what ever extension is appropiate
   LastName_FirstName_P3.what ever extension is appropiate

$j := \sqrt{-1}$

$pu := 1$

The induction machine to be used in the first three problems is operating in steady state and can be described by the following parameters:

$r_s := 0.03 \cdot pu$ $\quad L_{Ls} := 0.1 \cdot pu$ $\quad L_m := 2.0 \cdot pu$ $\quad L_{Lr} := 0.1 \cdot pu$ $\quad r_r := 0.03 \cdot pu$

Problem I

Part A:

1) Determine $slip_{rated}$ and ω_{r_rated}

and $\Lambda_{dr\_rated} = \left|\Lambda_{dqrA1}\right|$

Rated is defined to mean the operating condition such that:

$$\left|V_{dqs}\right| = 1.0 \cdot pu \quad \text{and} \quad T_{EM} = 1.0 \cdot pu \quad \text{and} \quad \omega_{es} = 1.0 \cdot pu$$

2) Create a vector diagram that includes:
(use V_{dqs} as the reference)

Λ_{dqsA2} $\quad \Lambda_{dqrA2}$ $\quad I_{dqrA2}$ $\quad I_{dqsA2}$ $\quad V_{dqsA2}$

(The subscript A2 denotes Part A subpart 2.)

3) Create a vector diagram that includes:
(put Λ_{dqr} at 0 degrees,
such that $\Lambda_{qr} = 0$)

Λ_{dqsA3} $\quad \Lambda_{dqrA3}$ $\quad I_{dqrA3}$ $\quad I_{dqsA3}$ $\quad V_{dqsA3}$

(The subscript A3 denotes Part A subpart 3.)

Indirect field oriented control is used to control the induction machine for Parts B and C.
Put λ_{dr} at 0 degrees in Parts B and C.

Part B: Set the command torque to zero: $T_{EMB} := 0.0 \cdot pu$

Calculate and create a vector diagram that includes: Λ_{dqsBx} Λ_{dqrBx} I_{dqrBx} I_{dqsBx} V_{dqsBx}

x equal 1, 2, and 3

For: ***1)*** $\omega_{rB1} := 0.0$ and $\Lambda_{drB1} = \Lambda_{dr\_rated}$

2) $\omega_{rB2} = \omega_{r\_rated}$ and $\Lambda_{drB2} = \Lambda_{dr\_rated}$

3) $\omega_{rB3} = 2 \cdot \omega_{r\_rated}$ and $\Lambda_{drB3} = \dfrac{\Lambda_{dr\_rated}}{2}$

Part C:

Calculate and create a vector diagram that includes: Λ_{dqsCx} Λ_{dqrCx} I_{dqrCx} I_{dqsCx} V_{dqsCx}

x equal 1, 2, and 3

For: ***1)*** $T_{EMC1} := 1.0 \cdot pu$ $\omega_{rC1} := 0.0$ and $\Lambda_{drC1} = \Lambda_{dr\_rated}$

2) $T_{EMC2} := 1.0 \cdot pu$ $\omega_{rC2} = \omega_{r\_rated}$ and $\Lambda_{drC2} = \Lambda_{dr\_rated}$

3) $T_{EMC3} := 0.5 \cdot pu$ $\omega_{rC3} = 2 \cdot \omega_{r\_rated}$ and $\Lambda_{drC3} = \dfrac{\Lambda_{dr\_rated}}{2}$

Put λ_{dr_cmd} at 0 degrees in Problems II and III.

You might find it easier to put Problems II and III in separate files from each other and Problem I.

Problem II: Repeat Parts B and C of Problem I for the situation where the parameter L_r/r_r in the "slip calculator" is in error by +25%.

Comment on the effect on steady state performance of such "detuning" of the controller.

Problem III: Repeat Parts B and C of Problem I for the situation where the parameter L_r/r_r in the "slip calculator" is in error by -25%.

Comment on the effect on steady state performance of such "detuning" of the controller.