The Induction Machine

Laboration 6 (Home version)

Updated May 15, 2020

Introduction

This lab exercise is normally performed as a demonstration lab, where the supervisor show a few things about how the induction machine is controlled and run. A demonstration like this has been recorded into one video. The video, together with the course book and the induction machine home assignment, contains all the necessary information and questions. This document acts just as a complimentary support.

The video of the induction machine demonstration is found in this playlist:
`https://www.youtube.com/playlist?list=PL3wWHGHhXw-dsQDStSvKOde1RDR4nMSwG`

Figure 0.1: QR-code for direct current controller video.

The setup

The video starts with a presentation of the lab equipment. The basic setup is the same as for previous lab. The same three phase inverter is used as for the active filter and synronous machine labs, but with the PMSM disconnected from the outputs.

When connecting the IM (as with any three phase machine), the order of the phases has to be considered, as well as the connection type. The three phases of the stator are wound separately, and can be coupled either as a star (Y) or delta (Δ) connection. Under the lid of the connection terminals on the top of the machine, it is clear that the three phases are already coupled as a star connection.

On the end of the shaft, the resolver is visible. This gives information to the controller about the rotors physical position (angle). This, together with the voltage and current that the inverter outputs, and a number of pre-set variables, is all the information the controller has to work with. The stator and rotor fluxes, and rotor current, is then determined through models.

1 Question 1: Flux and slip relation

In the first demonstration the flux reference is varied, but the torque reference is set to zero. When the rotor is turned, the stator current will move, trying to keep the flux constant in magnitude and angle - i.e. keeping the stator current in line with the rotor flux, so that no torque is produced.

Then the torque reference is varied while the rotor is held fixed. This makes the stator current move around. We know from the home assignment that the slip and the torque are proportional, so the higher the torque reference is, the higher the electrical frequency will be (to a certain point) when the mechanical frequency is zero due to strip of tape/hand on shaft.

Then the flux reference is varied again, when the torque reference is NOT zero. This affects the slip too. But how? And what can you say about why that relation occurs?

Hint: The IM introduction video could give you some advice.

2 Question 2: Stator and rotor flux relation to flux reference and torque reference

When the torque reference and flux reference is varied, the rotor and stator fluxes change. Make sure you cover all of the questions in your report:

2a. How does the stator flux change (in q and d) with regard to the flux reference?

2b. How does the rotor flux change (in q and d) with regard to the flux reference?

2c. How does the stator flux change (in q and d) with regard to the torque reference?

2d. How does the rotor flux change (in q and d) with regard to the torque reference?

3 Question 3: Torque reference effect on rotating machine

The rotor is no longer fixed, but let free to rotate. The flux reference is constant, but the torque reference is varied. What is (or isn't) happening to the system (mechanical frequency, electrical frequency, current magnitude, actual torque, etc) when the torque reference is varied? Why?

4 Question 4: Flux reference effect on rotating machine

The rotor is still free to rotate freely, but now the torque reference is constant while the flux reference is varied. What is (or isn't) happening to the system (mechanical frequency, electrical frequency, current magnitude, actual torque, etc) when the flux reference is varied? Why?

Report requirements

- Submit via email and attach your report as a **PDF file**, with **the email subject starting with** `IM_lab_Yourlastname`.
- You must submit your home assignment report to be allowed to do the lab. The first report does not have to be perfect, but you should have made honest attempts to complete all tasks.
- One report per student.
- You will receive your personal feedback eventually (there are a lot of submitted reports to keep up with), but before that you will receive some kind of support (like comment videos). If you realize you can improve your report before you get your personal feedback, you are free to do so, so minimize the risk of having to correct it later.
- The informal deadline of this task is 22nd of May. Later submission may result in later feedback.
- Feel free to ask for help or support via email, but please let the email subject start with `Help` or `Question`.