EE 304 Energy Conversion–Spring 2021 Final Project

Rules:

- Due date: **08 June 2022, 23:59**
- Please work on your own. **No communication/collaborations** with any other party.
- Please submit the answer files to the course's Moodle web page.

- **Problem Description**

A 13.8kV, 50MVA, 0.9–power–factor–lagging, 60Hz, four pole Y–connected synchronous generator has a synchronous reactance of 2.5Ω and an armature resistance of 0.2Ω. At 60Hz, its friction and windage losses are 1MW, and its core losses are 1.5MW. The field circuit has a dc voltage of 120V, and the maximum field current, I_F, is 10A. The current of the field circuit, I_F, is adjustable over the range from 0 to 10A for which the OCC of this generator is given as:

$$V_{\mathrm{T,OpenCircuit}}(I_F) = 20\,(1.05 - \exp(-0.3\,I_F))\ kV.$$

In all of the plots, the phasors need to be in vector shapes **not** as simple lines (Hint: check the command quiver).

1. Create a Matlab® function for plotting the phasor diagram of the generator for different values of the stator current I_A (Hint: I_A is complex valued!), the field current I_F, the terminal voltage V_T and the power angle (and perhaps the color of the objects in the plot). Explain briefly in your report theoretical calculations and include the code in the appendix of the report.
2. At rated conditions, compute and provide $|I_A|_{\max}$ and $|E_A|_{\max}$. Explain briefly in your report theoretical calculations. For rated conditions plot the phasor diagram and limit circles of the appropriate variables in **red**. Include the plot in the report.
3. For this part, assume that the terminal voltage remains at the rated values described in the question. Create a new plot which contains the red limit circles. On this new figure, using different colors, plot for 0.9–power–factor–lagging and 0.9–power–factor–leading E_A limit circles corresponding to $I_F = 2$A and $I_F = 6$A as well as the phasors of relevant quantities. Note that the total number of diagrams is four over the same plot excluding the red limit diagram.
4. For each case when varying power factor and I_F provide in the report a short analysis of generator behavior in terms of active and reactive power (Hint: see pg. 215 of the textbook) by observing the plots you created.

- **Report Format**

  – The report should have a straightforward and simple cover. The cover's header should contain the name of the institution, department, class and semester on top as well as the student's name and university ID number and the number of words placed in the middle of the cover page.

- Excluding the cover, the appendix and the figure caption(s), the report should contain no more than 500 words, a little more than the size of this document. Please provide the word count on the cover page (see below, Report Format Section). The report must be typewritten using either of **the default LaTeX font or Arial or Times New Roman 11pt. fonts**.
- The **Introduction** section must explain briefly the purpose of the work (Hint: check out the italic paragraph on the first page about the purpose). The **Materials and Methods** section must describe only necessary implementation details including technical details such as the software package's name and theoretical information about the calculations. The **Discussion and Results** section should provide observations and analysis.
- All figures must be appropriately contain titles, legends and axis labels.
- The code should be provided in the appendix. The code must be supported with concise comments for evaluation. Please remember that too many or long comments make the code intractable whereas a code without or too little comments makes it incomprehensible.

- **Objective and Grading**
  The objective of this assignment is to prepare the young engineers for the totality of the streamline in research and development process. Presenting the outcomes is extremely important. Accordingly, the grading will be weighted as: presentation (40%), theoretical results (30%) and implementation (i.e. the effectiveness of the code) (30%).