EE-306 Electromechanical Devices - Semester 161
Term Project

Towards Papermill Co-generation Facility

1 Objective

This term project primarily aims to make the students think out of the box and try to solve a given problem using their existing knowledge/experience and by exploring the relevant information from books (e.g., use of library) and web search. The students will build confidence in solving unknown but relevant problems in the field. The students will improve their teamwork skills.

2 Scope

The scope of the project is slightly above the level of usual class-work such as homeworks, exercise and practice problems.

3 Background

As we know, pulp and paper manufacturing involves a great deal of humidity, which presents a preventive maintenance and corrosion challenge. A paper mill is a factory devoted to making paper from vegetable fibers such as wood pulp, old rags and other ingredients using a Fourdrinier machine or other type of paper machine. The modern paper mill uses large amounts of energy, water, and wood pulp in an efficient and complex series of processes, and control technology to produce a sheet of paper that can be used in diverse ways.

3.1 Scenario I

Suppose that you were hired by a paper mill as an engineer, which is planning to use some of its waste products as an energy source from excess process steam, it means that the management is looking for installing turbine generators to produce electricity. Assume that the company has the following choices:

1. Three 10MW turbine generators, or
2. One 20MW and one 10MW turbine generator, or
3. A single 30MW turbine generator.

As a company's engineer, you were asked to give your opinion/recommendation about the three given choices to build this new electric co-generation facility. Also, the company advised you to consider cost, reliability and efficiency as the most important factors while giving your recommendation.

What will be your choice/recommendation? Justify your answer by explaining the advantages and disadvantages of each choice and support your claim.

Hints: You can think of a few special cases with different loads of generation facility, for example, you may assume expected loads of generation facility like 8MW, 12MW, and 18MW in order to discuss reliability aspect of the plant. Also, you can assume appropriate per unit costs of three generations (C1 ($/MW), C2 ($/MW), and C3 ($/MW)) with the condition that $C_1 < C_2 < C_3$ and discuss cost issues. Similarly you can justify efficiency aspect of your choice.
A brief answer of about 1 paragraph is expected. Note that you are not required to give answers in numerical figures.

3.2 Scenario II

Now suppose that the company has finally decided to install three 10-MW turbine generators to take advantage of the situation regardless of your opinion in Scenario I. Where each generator has a rating of 12.5 MVA, 4160-V, 0.8-PF-lagging, three phase, 60 Hz, two-pole, and Y-connected synchronous generator with a synchronous reactance of 1.10 Ω and an armature resistance of 0.03 Ω. Also, generators 1 and 2 have a characteristic power-frequency slope of 5MW/Hz, and third generator has a slope of 6 MW/Hz. Your manager advised you to do the following calculations in order to finalize the design process:

1. Determine the power supplied by each of three machines (generators) at the actual system frequency of 60Hz if the no-load frequency of each of three generators is adjusted to 61Hz.
2. Also, determine the maximum power the three generators can supply in this condition without the ratings of one of them being exceeded. At what frequency will this limit occur? Also, How much power does each generator supply at that point?
3. If we need to get all three generators to supply their rated real and reactive powers at an overall operating frequency of 60HZ, what would have to be done?
4. Determine internal generated voltages of the three generators under this condition.

$\preccurlyeq \preccurlyeq$ End of project statement $\succcurlyeq \succcurlyeq$
Good Luck!

see instructions on next page

Instructions to Candidates

- This is NOT an individual project. The students are encouraged to work in teams of two, where each team member would share equal grade
- You are required to submit a written project report
- Use formal title page of the report showing the names of team members and IDs
- The progress report should be computer generated one
- Handwritten report will not be accepted in any case
- The report should mention clear calculations, formulae used, and circuit diagrams with clear labeling
- The report must describe the assumptions made, if any
- Most importantly, a section "Discussions" should be added at the end of your report and a brief technical analysis of your calculations/project must be provided, e.g., you can give your recommendation to enhance the design
- You are encouraged to look into **Lecture Slides** first to find out the relevant concepts. Also, you can consult your course instructor if you have any confusion
- You can assume some appropriate data, if you feel it's missing. However, wrong assumptions will be penalized
- Finally, team members (group-mates) are highly encouraged to contribute equally within their own group but no team member/group is allowed to cross-communicate with other groups/members
- **Grading:** This project carries 5 absolute marks in total. The report carries 2 absolute marks, which will be based on clarity of calculations, clear writing and presentation in general. Late submission of the report will NOT be accepted
- **Report Submission:** The deadline for the submission of project report is:

Monday, 11 January 2017, 4:00PM