**EE 488 Power System Analysis I [Spring 2024]**

**Simulation Lab #1 [1]**

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**Introduction**

The purpose of this lab is to design a Power Transmission system with a single Generator as the Main Power source. The Generator is a Slack Generator, the power generated is dependent on the design of the entire system including the loads. The system delivers power to 3 Loads Busses 2, 4, and 4 respectively; two of the Load Bus have power going through a Step-Up and Step-Down Large Power Transformers (LPT’s), the other Load Bus is connected directly to the Slack Bus without an LPT. The Lab will help analyze the Power losses incurred during Power transmission to 3 equal Load Buses with different transmission line setups.

You have a lot of unnecessary capitalization on this page

**Methods, Results and Discussion**

The Lab is performed using Power World Simulator. The Different Elements (Generator, Buses, Loads, Transformers, and Transmission lines) are put together in the simulator and run to obtain the desire result with close to 0 mismatch at all buses. Fig.1 shows the Simulation Diagram.

Good simulation run on the next page:

A line of lines with numbers and symbols

Description automatically generated with medium confidence

Fig.1. Lab 1 Simulated Model

Don’t forget I need a blank line (carriage return) above and below each caption

The results of the Lab are obtained from the Model Explorer under the case Information and exported as an excel spreadsheet.

Table 1 shows the importance of having large Power Transformers in power transmission systems. The power loss at the transmission Line from Bus 1 (Slack Bus) to Bus 2 at Load 1 is far greater than the Power Loss at the other two Lines (path) that are connected to Bus 3, and 4. Equation (1) determines the real power [MW] efficiency of the system.

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

First highlight below is an example of a “helper verb”. Second highlight is past tense.

In addition to the adding LPT’s the application of Shunt switches at the Load can also reduce power loss as seen in the percentage of Voltage loss at Bus 3 and 4. The addition of the shunt switch at Bus 4 reduced the lost by an additional 50% compared to the lost at Bus 3 (from 11.38% to 5.79%). The percentage of Voltage Loss is determined using equation (2)

Please make sure all of your equation numbers appear lined up at the right margin

|  |  |
| --- | --- |
|  | (2) |

For this Lab, the power factor correction at Load Bus 4 is determined by calculating the reactive Power needed to obtain a Power factor 0.97% lagging. The value was increased by 15% to obtain the Nominal MVAR, equation (3) shows this formular.

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  | (3) |

All captions should be centered on the page

Table 1. Power Result of Power and Voltage Loss at each Load Bus



The shading of the spreadsheet cells above is a little dark! Numbers all look good.

Table 2 shows that the Power generated at the Slack generator is close to the Power delivered to the 3 loads at the end of the transmission system. In an ideal system the overall Power generated will be equal to Power delivered to the end of the Line as suggested in equation (4). The overall system is 99.67%, this might not be the case without the addition of LPT’s and a shunt switch which improves the power factor of at the loads.

|  |  |  |
| --- | --- | --- |
|  |  | (4) |

Table 2. Shows Total Power Produced [MW and MVAR] and Power Delivered [MW and MVAR]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Power Check Table** | | | | | |  |
| **Power Generated** | | **Power Delivered** | | | |  |
| **MW** | **MVAR** | **At Loads L1-L3 [MW]** | **At Loads L1-L3 [MVAR]** | **Loss at Transmission Process [MW]** | **Loss at Transmission Process [MVAR]** |  |
| 132 | 122 | 11.86 | 8.37 | 16.34 | 49.03 |  |
|  |  | 49.96 | 34.96 | 0.95 | 4.74 |  |
|  |  | 50 | 12.8 | 0.6 | 3 |  |
|  |  |  |  | 0.95 | 4.74 |  |
|  |  |  |  | 0.6 | 3 |  |
|  |  |  |  | 0.19 | 0.57 |  |
|  |  |  |  | 0.12 | 0.36 |  |
| Total | | 111.82 | 56.13 | 19.75 | 65.44 |  |
|  |  |  |  |  |  |  |
| **Total [MW] Delivered** | | 131.57 |  | **System Efficiency [MW]** | | 99.67% |
|  |  |  |  |  |  |  |
| **Total [MVAR] Delivered** | | 121.57 |  | **System Efficiency [MW]** | | 99.65% |

Tables should also be centered on the page

**Conclusion**

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The experiment shows how Power loss can be minimized in power systems. It gives an understanding of How power factor can be improve using shunt switches. The Step-Up Transformers are necessary at the Production end and keep the starting voltage at the beginning of the transmission line uniform and Step-Down Transformers are needed to bring down the power to a safe level for loads at the end of the transmission line.

[1] [IEEE Editorial Style Manual for Authors](https://journals.ieeeauthorcenter.ieee.org/wp-content/uploads/sites/7/IEEE-Editorial-Style-Manual-for-Authors.pdf)

Your simulation run was fine and the calculations for Table 1 were fine as well. I did not see answers to a number of my questions in the lab handout. Please go back through the handout and look at the solutions document I posted as well to see what all is missing.

Computer usage consisted of PowerWorld and creating at least one spreadsheet. You did both things just fine, except see my comment on shading on the spreadsheet. It was so dark in many cases that I nearly could not read the data in the cells.

In your writing, please be consistent. I highlight examples here and there of switching tense (between past tense and present tense) and also use of helper verbs (such as “can” and “can be”). The best way to write in IEEE is present tense, passive voice. For example, the sentence you wrote under Fig. 1 is:

The results of the Lab are obtained from the Model Explorer under the case Information and exported as an excel spreadsheet.

This is an example of present tense, passive voice. Also, please avoid all the unnecessary capitalization of words you have throughout.

There were some formatting issues. First, all equation numbers must appear lined up at the right margin. Second, be sure to have an actual, blank line (using a carriage return) above and below all captions. This is for me to make comments. Finally, all captions, tables, and figures should be centered.

|  |  |  |
| --- | --- | --- |
| **Item** | **Possible** | **Actual** |
| Technical work | 50 | 38 |
| Computer use | 20 | 18 |
| Written presentation | 20 | 15 |
| Format (IEEE) | 10 | 7 |
| **Total** | **100** | **78** |