Lab Four
Power Systems Analysis
EECE5682

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Abstract

This laboratory experiment explores three phase transformers in both voltage magnitude shifting and phase shifting applications. The simulated three phase circuits were balanced, and contained regulating transformers used to modify real and reactive power flow, as well as voltages.

1 Introduction & Objectives

We begin by constructing a three-phase phase shifter as follows:

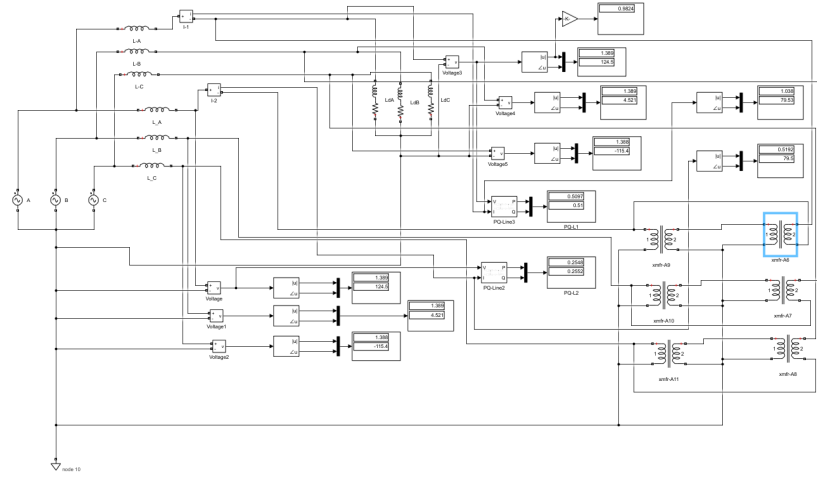Figure 1: Voltage Regulator Circuit Construction

This circuit was then used to simulate the conditions indicated below.

2 Results & Analysis

2.1 Part D: Simulating with Voltage Magnitude Regulation

We now change to a voltage magnitude regulator, implemented in the following schematic:

2.1.1 Repeating Part B with Voltage Magnitude Regulation

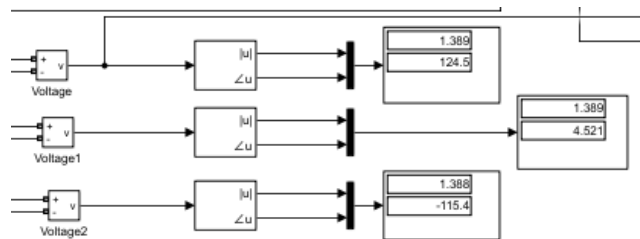Using the new schematic, we run Part (b) again. This gives us:

Figure 2: Secondary Line Voltage Magnitude and Phase (Regulator, 100:.01)
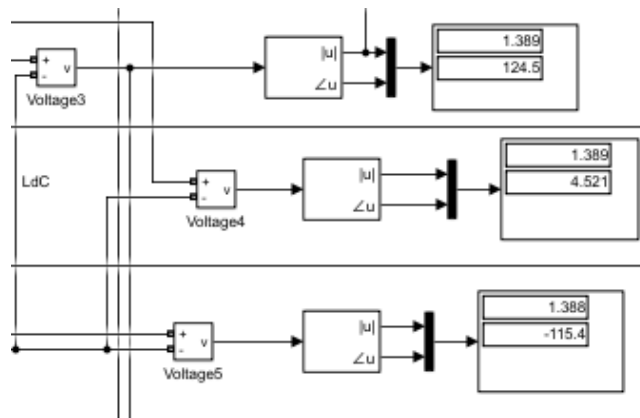
Figure 3: Primary Line Voltage Magnitude and Phase (Regulator, 100:.01)

We may observe that the line voltages and magnitudes are identical, as with the phase regulator with the same turns ratio. We now find the power flows:
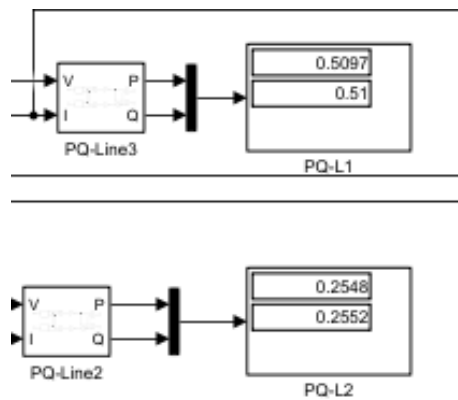

Figure 4: Real/Reactive Power Flows (Voltage Regulator, 100:.01)

As with the initial case, we see that the real and reactive power flows in the primary line are double those on the second line.

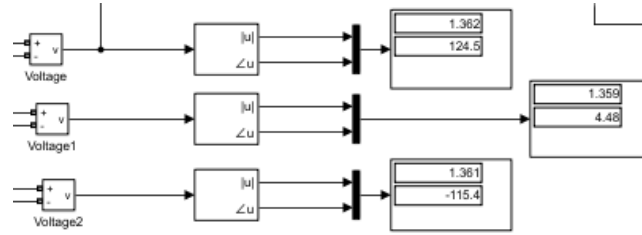### 2.1.2 Repeating Part C with Voltage Magnitude Regulation

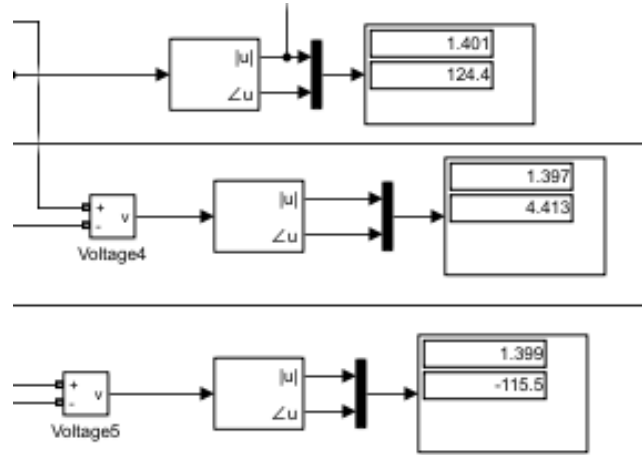Figure 5: Secondary Line Voltage Magnitude and Phase (Regulator, 100:3)

Figure 6: Primary Line Voltage Magnitude and Phase (Regulator, 100:3)

We may observe that the primary line voltage phases lead very slightly, by approximately $.67°$. On the other hand, secondary line voltage magnitudes lead slightly, by about $.38[p.u.]$. We now find the power flow:
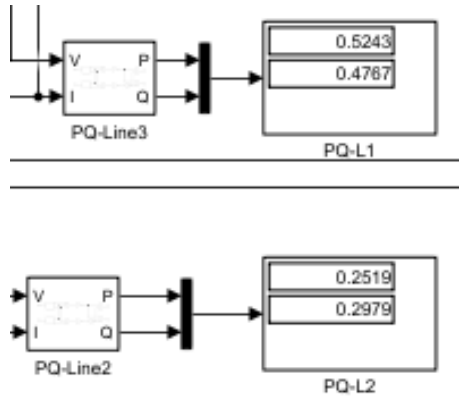
Figure 7: Real/Reactive Power Flows (Voltage Regulator, 100:3)

We may observe that the real power in the primary line is more than double that of the secondary line, while the ratio of the reactive power is just below 2. Thus, we see that this case is best for real power flow through the secondary line.

3   Conclusion

a. For the voltage regulating transformers, we may see that, in the first case (as with the phase regulating transformers) the voltage magnitudes and phases are equivalent, while the powers are doubled. For the second case (100:3), the phases are slightly lower and the magnitudes slightly higher in for the primary line voltages. When it comes to power, the ratio between the two lines is greater than two, while the reactive power ratio is less than two. Thus, we may conclude that reactive power is more affected by changes in voltage magnitude. We can assume this is so because, based on our equations, the reactive power would be proportional to the magnitude of the voltage squared over the reactance.