Group Project 1 – Power System Component Analysis

ECE 4610

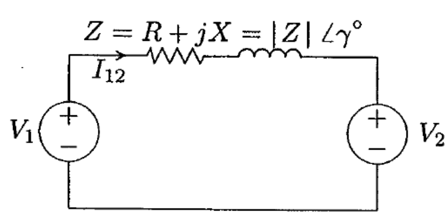
Project Objectives:

- Capable to analyze single-phase and three-phase balanced circuit;
- Capable to analyze transformer using equivalent circuit;
- Capable to conduct MATLAB programming for component analysis and plot demonstration.

Project submission requirements:

- The project team can have maximally two group members. For the project report, it is required to report the responsibility of each group member.
- The submission file should include a complete project report answering all following questions. **All MATLAB codes and resulting plots should also be included in the project report.** All MATLAB programming files need to be included in the submission. Submit your group project as a zip file and upload on iLearn.

Question 1 – As shown in Figure 1, two voltage sources $V_1 = 150\angle{-5°}V$ and $V_2 = 120\angle 0° V$ are connected by a series impedance $Z = 4 + j8\ \Omega$.



a) Determine the complex, real, and reactive power supplied or received by each source.

b) Determine the power loss of the connection line.

c) Varying the phase angle of V_1 from $-25°$ to $5°$ in the step of $3°$. Voltage magnitudes of two sources are kept constant as well as the phase angle of V_1. Write the MATLAB programs to compute the complex power for each source and the line loss. Tabulate and plot the real powers P_1, P_2, P_L versus the phase angle θ_{V1}. What is your observation from the results and why?

d) Varying the voltage magnitude of V_1 between 60% and 100% of the rated value in the step of 1 volt. Voltage magnitude of V_1 is kept constant as well as the phase angles of two sources. Write the MATLAB programs to compute the complex power for each source and the line loss. Tabulate and plot the reactive powers Q_1, Q_2, Q_L versus the voltage magnitude of $|V_1|$. What is your observation from the results and why?

Question 2 – A balanced three-phase resource with the following instantaneous voltage representation:

$$v_{an} = 1414\cos(120\pi t)\,V$$

$$v_{bn} = 1414\cos(120\pi t - 120°)\,V$$

$$v_{cn} = 1414\cos(120\pi t - 240°)\,V$$

The resource supplies two loads connected in parallel: one balanced Y-connected load that has an impedance of $300 - j400$ ohms per phase and one balanced delta-connected load with impedance $Z_{\triangle} = 3000\angle 53°$ ohms per phase.

a) Calculate the real, reactive, and complex power consumed by each load and total real, reactive, and complex power.

b) Calculate the total current and currents flowing through each load.

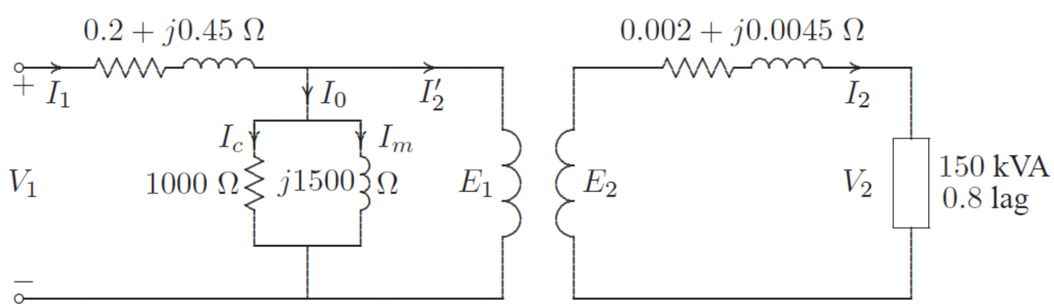
c) Write a MATLAB program to do the following:

c-1) Calculate the total real, reactive, and complex power. Are the results the same as question a)?

c-2) Calculate the total current of voltage source. Is the result the same as question b)?

c-3) Plot the instantaneous real power and reactive power of each load over the range of $0: 0.05: 2\pi$ on the same graph.

Question 3 – A 150-kVA, 2400/240-V single-phase transformer has the parameters shown below:



a) Determine and draw the equivalent simplified circuit referred to the primary side.

(Note: for simplified circuit, the primary and secondary winding series impedance are combined into Z_e)

b) Determine and draw the equivalent simplified circuit referred to the secondary side.

c) Find the primary side voltage V_1 and voltage regulation when transformer is operating at full load 0.8 power factor lagging and the load is operated at the rated voltage on secondary side.

(Note: **voltage regulation** is calculated as $VR = \frac{|V_{1nl}| - |V_1|}{|V_1|} \times 100\%$, where V_{1nl} denotes primary side voltage when there is no load and V_1 denotes primary side voltage when there is full load.)

d) Find the primary side voltage V_1 and voltage regulation when transformer is operating at full load 0.6 power factor leading and the load is operated at the rated voltage on secondary side.

e) Write a MATLAB code to plot the voltage regulation as a function of load at the secondary side going from no-load to full load at power factor of 0.8 lagging, 0.8 leading, and unity respectively.

(Hint: this means, iteratively doing part (c) from no-load on the secondary side all the way to full load. Only considering the magnitude increment.)