ECE 523 Exam 1 November 2019

EXAMINATION RULES

1. This is an open-book/open-note take-home exam.
2. I can e-mail a MathCAD file with the exam problems to you if you would like a copy.
3. Do your own work on this examination. You are on your honor. Therefore, you will neither give nor receive aid on this examination, except from the *course* instructor. If you violate this trust, you will receive the grade of zero for this examination.
4. Show all of your work! Make it neat. *No* partial credit will be given if I can not easily follow your work.
5. Cite the sources of information you use for your answers
6. You have 3 days to complete the exam from the time you receive it from your proctor.
7. ***Do NOT e-mail your completed exam to the course TA.***
8. Pease read and sign the following statement when you finish the exam:

I certify that I have neither given nor have I received any help on this examination, except from the course instructor.

SIGNED: _____

PRINTED NAME:_____

DATE:_____

1. _____/25 pts

2. _____/35 pts

3. _____/40 pts

Total: _____/100 pts

Problem 1 (25 pts) Consider a case where an equivalent load of 80 MW and 20 MVAR lagging is to be connected BUS 3 in the system below.

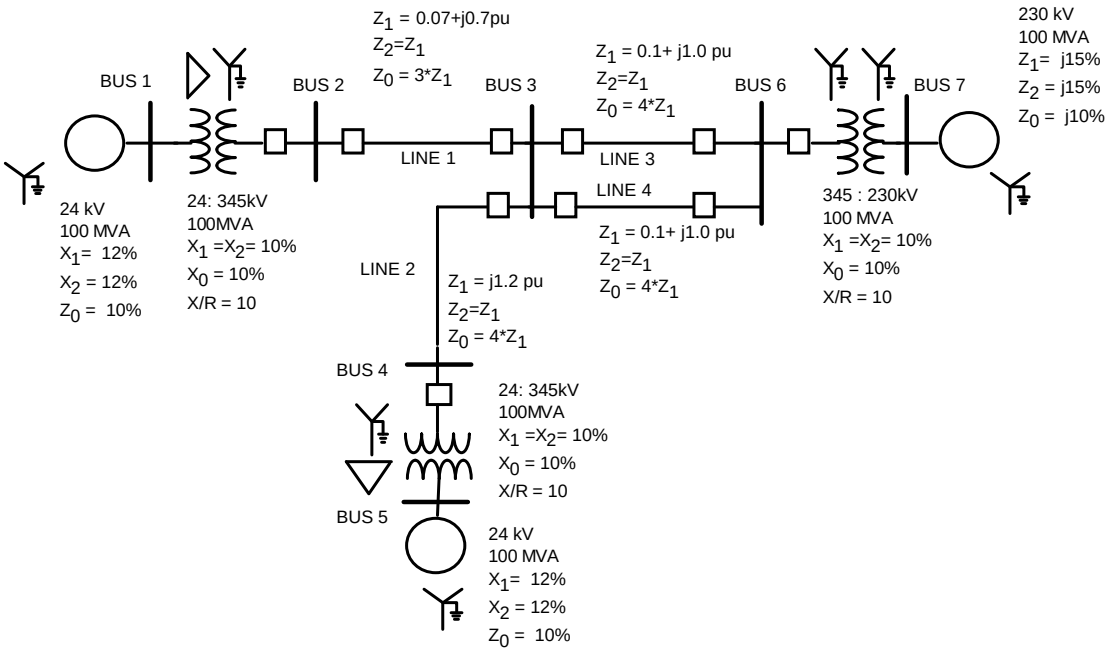
a). If the load is represented as a connection to a neighboring power system, and is treated as balanced positive sequence, how would model it for fault studies in the sequence domain, and how would you include the effect of the power flow in your fault studies? What other information do you need, if any?

b). How would the answer from part A change if you instead treated the load as a constant impedance load?

c). How would the answer from part A change if you instead treated the load as a constant current load?

d). How would the answer from part A change if you instead treated the load as a constant power load?

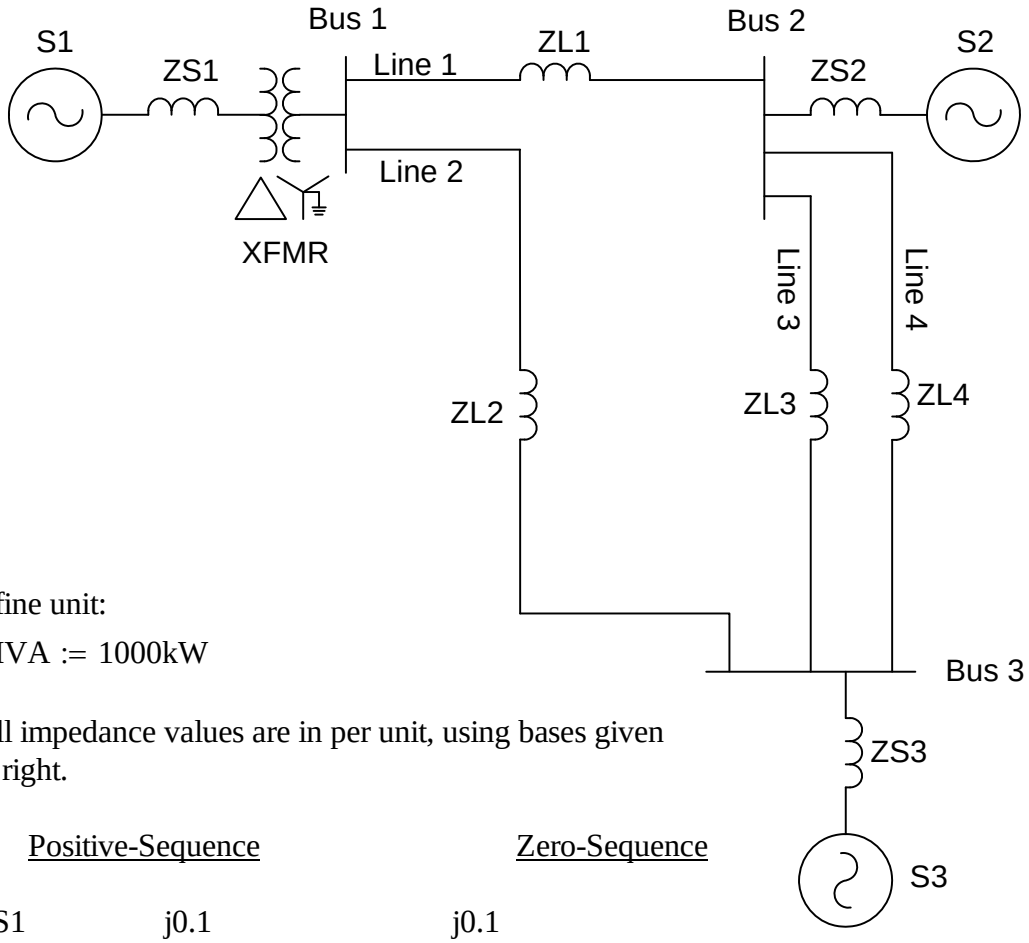
e). How would your answer from part A change if the load was 40% constant power, 40% constant current and 20% constant impedance?



Problem 2 (30 pts) The owner of the industrial co-gen facility connected to Bus 1 (point of common coupling or PCC) of the system below needs system equivalent impedance information in order to set their local protection equipment. You can use a fault program if you wish to do so.

I. Calculate the minimum and maximum short circut MVA (both 3 phase and single line to ground fault cases -- hint: MVAsc was discussed in one of the early lectures) based on the following combinations:
A. Everything in the system on-line.
B. Any one of the lines out of service, but S2 and S3 both in service
C. Either S2 or S3 out of service, but all lines in service.

II. Comment on whether your results willchange if the point of common coupling were on the low side of the transformer.



Define unit:

MVA := 1000kW

All impedance values are in per unit, using bases given at right.

	Positive-Sequence	Zero-Sequence
ZS1	j0.1	j0.1
XFMR	j0.2	j0.2
ZS2	j0.2	j0.35
ZS3	j0.2	j0.7
ZL1	0.01 + j0.15	0.06 + j0.5
ZL2	0.05 + j0.5	0.20 + j2.0
ZL3	0.02 + j0.2	0.07 + j0.7
ZL4	0.02 + j0.2	0.07 + j0.7

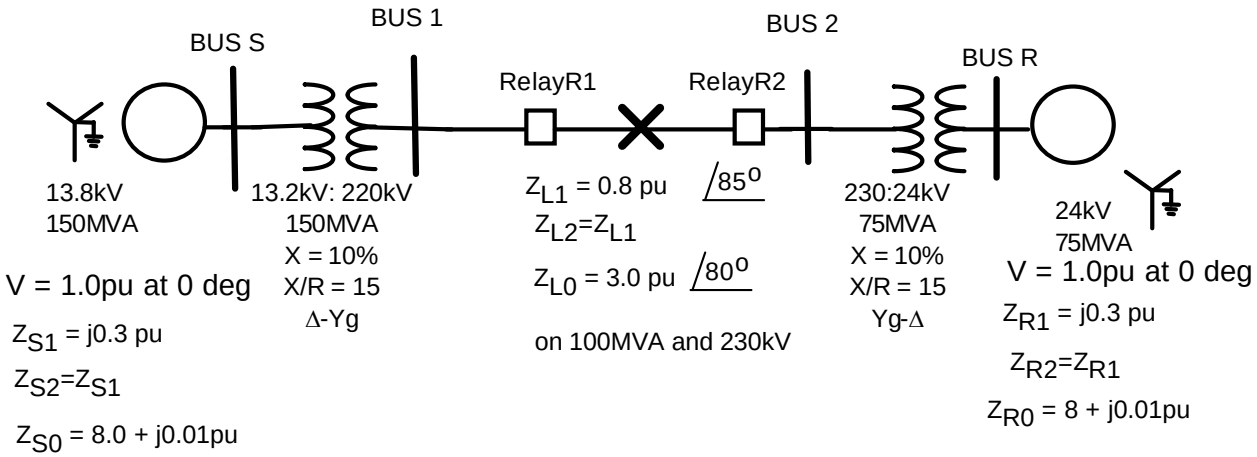
$S_B := 100MVA$

$V_{S1} := 24kV$

Transmission system: 230kV

Transformer: 24kV:230 kV, 100MVA

Problem 3. (40 pts) Given the network described below:



A. Calculate the sequence domain voltages and currents seen at BUS1 (RelayR1) for SLG, LL, and DLG faults with $R_f = 0$ at the following locations (you can use a fault program if you wish to do so).

(1) Bus 1
(2) 33% of the way down the line starting from BUS1 and going toward BUS2
(3) 67% of the way down the line starting from BUS 1.
(3) A fault at BUS2

B. Plot the sequence voltage magnitudes seen at BUS1 (RelayR1) versus fault location between BUS1 and BUS2 if $R_f = 0$ for the cases from part **A**.

C. For quantities measured at RelayR1, plot phase angle relationships between (1) the positive sequence voltage and positive sequence current, (2) the negative sequence voltage and negative sequence current, (3) the zero sequence voltage and zero sequence current, and (4) between the negative sequence current and zero sequence current for the fault cases from part **A.** versus fault location between BUS1 and BUS2.

D. Comment on your results