ECE 524 Final Exam Summer 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. ***You have 3 days to complete the exam the exam from the time you receive it from your proctor.***
6. ***Pease read and sign the following statement when you finish the exam:***
7. I certify that I have neither given nor have I received any help on this examination, except from the course instructor.

SIGNED: _____

PRINTED NAME:_____

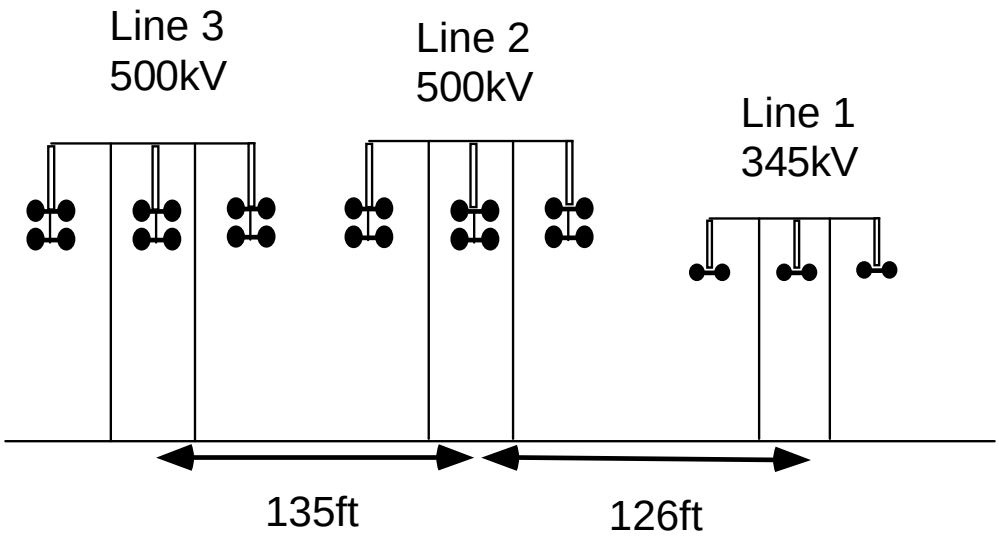
DATE:_____

1. _____/48 pts

2. _____/52 pts

Total: _____/100 pts

1. (48 pts) The three lines below run in parallel through the length of the same 75 mile corridor.



Line information (earth resistivity = 100 ohm-m:

Line 1: Height at tower = 73ft
Heigth at midspan = 55 ft
Horizontal spacing between adjacent phases = 35 ft
Number of conductors per bundle = 2, positioned as shown above
Bundle spacing = 18 inches
Conductor outside diameter = 1.108in
DC Resistance = 0.12 ohm/mile
Conductor GMR = 0.4476 in

Line 2: Height at tower = 76ft
Heigth at midspan = 33 ft
Horizontal spacing between adjacent phases = 39 ft
Number of conductrs per bundle = 4, positioned as shown above
Bundle spacing = 18 inches
Conductor outside diameter = 0.95in
DC Resistance = 0.15 ohm/mile
Conductor GMR = 0.3876 in

Line 3: Height at tower = 77ft
Heigth at midspan = 33 ft
Horizontal spacing between adjacent phases = 35 ft
Number of conductors per bundle = 4, positioned as shown above
Bundle spacing = 18 inches
Conductor outside diameter = 1.0in
DC Resistance = 0.145 ohm/mile
Conductor GMR = 0.4260 in

Assume that lines 2 and 3 are untransposed. Line 1 is transposed every 25 miles.

Do the following:

A. (14 pts) Create distributed parameter line model (Bergeron) of the coupled circuit for the three lines above using your EMTP program.

Provide a text copy of the line constants output from your program with your solution in addition to providing your simulation model.

Test your lines with ideal sources connected to one end the other end open. Plot the steady-state charging currents.

B. (6 pts) Connect line 1 to an ideal source with V_{LL} = 360kV, line 2 to an ideal source with V_{LL} = 550kV and leave line 3 open at each end. Connect a unity power factor loads to line 1 and line 2, drawing 440A and 830A respectively.

Simulate this and plot the line to neutral and line to line voltages on Line 3.

C. (6 pts) Repeat part B with line 3 grounded through a Y-connected 5 ohm resistance each end. Measure the currents flowing in each phase on line 3

D. (5 pts) Comment on your results from parts B and C. What is the main source of coupling in this case?

E. (12 pts) Now repeat parts B and C with separate simulations with a SLG, LL, DLG andthree phase fault applied at the midpoint of line 2. Plot the sending end currents for all three lines for each case.

F. (5 pts) Comment on your results for part E.

2. (52 pts) Short answer

(a) (9 pts) How accurately can you locate faults using a travelling wave fault locator if your time stamps are accurate to plus or minus 1 microsecond (give an approximate answer in miles giving your assumptions)? Does this change for underground cable, how? Which is modes do you use (first line mode, second line mode, ground mode)? Explain

(b) (6 pts) How much of the power system must be modeled for performing studies to see whether or not a flashover will occur if lightning strikes the ground wire of a transmission tower near the middle of a 100 mile transmission line? Is the lightning strike modelled as a voltage source or a currentsource (explain your answer).

(c) (6 pts) Is a large footing resistance or small footing resistance better for decreasing the chances of a back flashover if lightning strikes the top of a grounded transmission tower? Large or small relative to what?

(d) (7 pts) Insulation coordination studies can be performed using rules of thumb, deterministic studies and statistical studies. What are the trade-offs with these three options?

(e) (7 pts) How do the ground wires impact the phase and modal domain R', L', and C' values for a transmission line used for simulation? Will there still be one ground mode if there are multiple static wires? What difference is there if the ground wire is segmented or continuous, if any?

(f) (7 pts) Under what circumstances would you want to use a frequency dependent distributed parameter line model in an EMTP simulation for overhead lines? How about cables? What does this model represent and why is it useful to use over a single frequency travelling wave (constant parameter) model?

(g) (5 pts) What does BIL stand for? How about BSL? Explain what each represents and how they are used.

(h) (5 pts) Describe how a transformer be modeled for high frequency transient analysis differ from models used for low frequencies? At what frequencies do the differences start to be significant? Does saturation matter more or less as frequency goes up?