Portland State University

Electrical & Computer Engineering
EE 347 Electrical Power Systems I

-Final Exam (Practice)-

Students have 110 minutes to complete this exam. Write neatly, box answers, and show all calculations. This is an open-book, open-note exam. No assistance from any other person shall be solicited or accepted.

This is exclusively an open-book, open-note exam. Students may refer to their own course notes and assignments. Students may use any of the texts listed in the course syllabus. However, students shall not refer to any other sources.

Students may use a calculator. No other means of calculation, such as Matlab, MathCAD, etc., are permitted.

This exam consists of four problems, each worth 25 points. Write neatly, box answers, and show all calculations. It is imperative to ensure student work is legible; illegible work will receive no credit.

All work must be done within the pages provided in this file; no additional pages may be amended. This coversheet shall accompany the submission.

Please sign below acknowledging acceptance of these terms.

Student name, printed: ________________________

Student Signature: ________________________

Start Time: _______ End Time: _______

Problem 1: _______

Problem 2: _______

Problem 3: _______

Problem 4: _______

Total: _______

Problem 1 (25 points)

A Wye-connected three-phase load has the following sequence currents:

$$\begin{bmatrix} I_{A0} \\ I_{A1} \\ I_{A2} \end{bmatrix} = \begin{bmatrix} 0.2A\angle -75° \\ 2.6A\angle 0° \\ 0.6A\angle 35° \end{bmatrix}$$

a. Is the load grounded? Explain your reasoning.

b. Using the sequence currents above, calculate the line currents feeding the load.

c. Illustrate the line currents using the phasor diagram provided below.

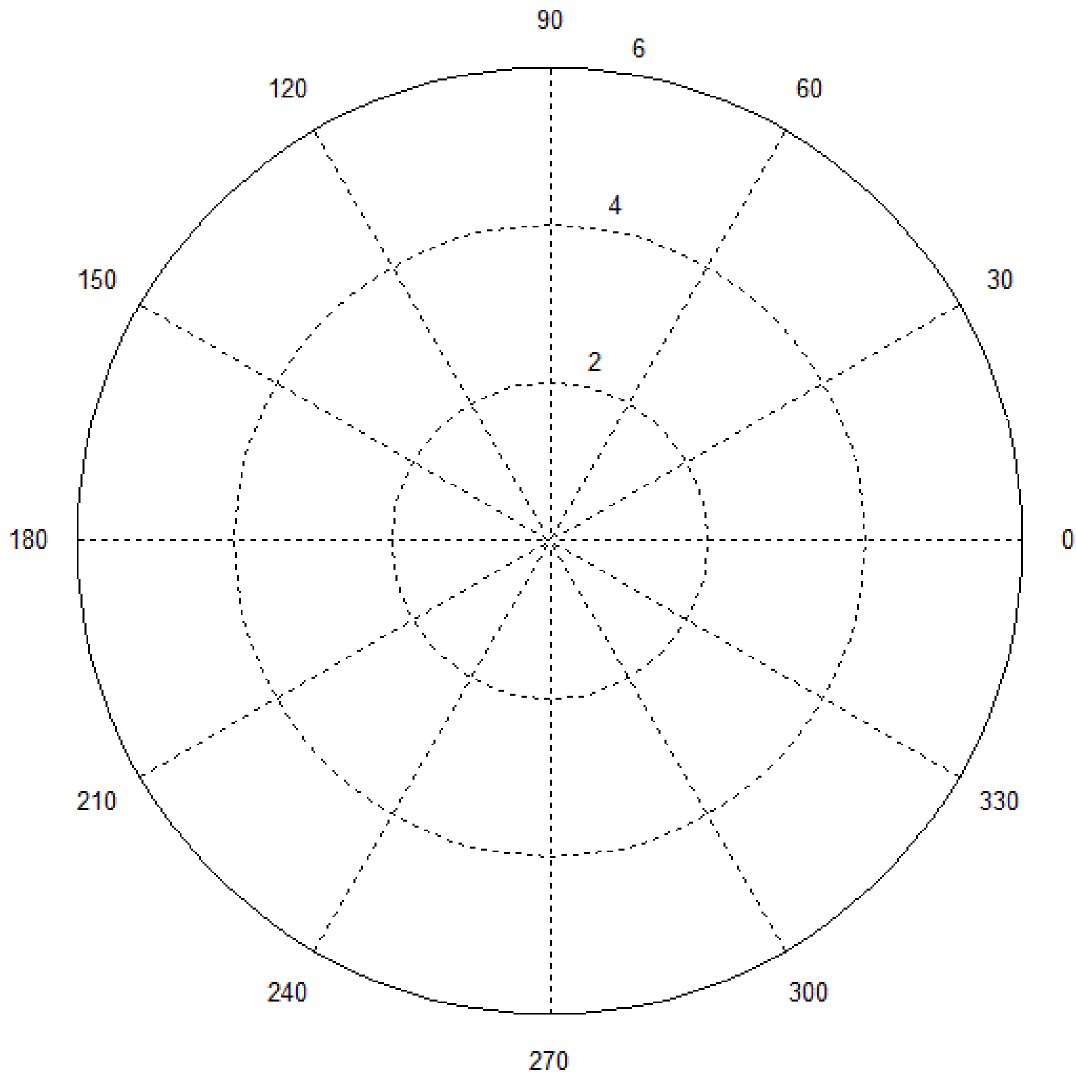

Figure 1 Use the above polar plot to display the unsymmetric currents $\mathbf{I}_A$, $\mathbf{I}_B$ and $\mathbf{I}_C$.

Problem 2 (25 points)

A 1.8 MVA, 12.47 kV, 3φ load presents a 0.81 lagging power factor.

a. Calculate the amount of reactive power required to bring the power factor to 0.95 lagging.

b. The load is fed via a distribution feeder with an impedance of [R, X] = [2%, 5%]. Compare the transmission efficiency before and after the compensation capacitors are in place. Assume the service is load regulated.

Problem 3 (25 points)

A 12.47 kV, three-phase distribution feeder is 2.7 miles long and can wheel up to 5 MVA. Merlin conductors were hung using an equilateral triangular spacing scheme, with conductor spacing of only 4 inches. Assume a 25 ºC operating temperature.

1. Considering the very narrow spacing between conductors, determine whether a short t-line model is sufficient to represent the feeder or if a medium model is required. Do so by commenting on the ABCD coefficients.

2. Using the most appropriate model, calculate the voltage regulation when a rated load with 0.85 lagging power factor is attached.

	kcmil	Al/SS	DC (Ohms/1000ft) @20C	60Hz AC (Ohms/1000ft) @25C	@50C	@75C	Capacitive Reactance (MOhms-1000ft)	Inductive Reactance (Ohms/1000ft)	GMR (ft)
WAXWING	266.8	18/1	0.0644	0.0657	0.0723	0.0788	0.576	0.0934	0.0197
PARTRIDGE	266.8	26/7	0.0637	0.0652	0.0714	0.0778	0.565	0.0881	0.0217
MERLIN	336.4	18/1	0.051	0.0523	0.0574	0.0625	0.56	0.0877	0.0221
LINNET	336.4	26/7	0.0506	0.0517	0.0568	0.0619	0.549	0.0854	0.0244
ORIOLE	336.4	30/7	0.0502	0.0513	0.0563	0.0614	0.544	0.0843	0.0255
CHICKADEE	397.5	18/1	0.0432	0.0443	0.0487	0.0528	0.544	0.0856	0.024
IBIS	397.5	26/7	0.0428	0.0438	0.0481	0.0525	0.539	0.0835	0.0265

Problem 4 (25 points)

A power system consists of four 138 kV busses with three transmission lines between them. System base values are S_{base} = 100 MVA, V_{base} = 138 kV:

The per-unit bus admittance matrix, $\mathbf{Y}_{Bus}$, is

$$\boldsymbol{Y_{BUS}} = \begin{bmatrix} 16.0 - j63.6 & -(4.30 - j25.6) & -(11.7 - j38.0) & 0 \\ -(4.30 - j25.6) & 32.8 - j67.6 & 0 & -(28.5 - j42.0) \\ -(11.7 - j38.0) & 0 & 11.7 - j38.0 & 0 \\ 0 & -(28.5 - j42.0) & 0 & 28.5 - j42.0 \end{bmatrix}$$

a. Draw a per-unit, single-line diagram. Label all bus numbers. For all transmission lines, calculate and label the impedance.

A second transmission line is to be connected within the system to alleviate excessive loading. This new line will be placed parallel to the existing 1-3 line. This new line has an impedance $\mathbf{Z}_{1\text{-}3,\text{ new}} = 3.9 + j7.8\ \Omega$.

b. Add this new line to the single-line diagram, appropriately labeled

c. Determine the new per-unit bus admittance matrix, $\mathbf{Y}_{Bus,\text{ new}}$.