EEE 33 1st Semester AY 2011-2012: Homework 6

Problem 1 – Complex Power

Three parallel loads are supplied by a 440V source. Load A draws 10kVA at 0.8 pf lead, load B draws 15kW at 0.5 pf lag, and load C draws 5kW at unity pf. Determine the following:

a. the real power, reactive power, and apparent power drawn by each load
b. the real power, reactive power, and apparent power supplied by the 440V line
c. the current drawn by the combined load
d. the equivalent power factor of the combined load
e. the value of the capacitance that must be connected across the line so that the source will operate at unity pf at 60 Hz
f. the value of the capacitance in e if the source should operate at 0.9 pf lead instead

Problem 2 – Phasor Diagrams

The phasor quantities in the table below describe all the phasor voltages and currents of an RLC circuit supplied with a sinusoidal voltage source V_S.

PHASOR QUANTITY	MAGNITUDE (V OR A)	ANGLE (DEGREES)
I_1	3	90
V_{1a}	12	90
V_{1b}	6	180
V_{1c}	15	0
V_2	15	53.1301
I_{2a}	5	-36.8699
I_{2b}	1	53.1301
I_S	4.669	9.8658
V_{RS}	46.6905	9.8658
V_S	58.5235	19.9831

a. Draw the phasor diagram. Label the magnitudes and phase angles in the diagram.
b. From the phasor relationships, determine the values and connections of the different circuit components.

Problem 3 – Balanced Three-Phase Systems

A three phase Y-connected load is drawing 20kW at 0.8 pf lag from a Δ-connected generator through feeders having a resistance of 1.0 Ω and inductive reactance of 1.0 Ω each. If the line to line voltage at the load is 230V, compute the following:

a. the magnitude of the load phase voltages
b. the magnitude of the line current
c. the magnitude of the generator line to line voltages
d. the magnitude of the generator phase currents
e. the operating power factor of the generator

Problem 4 – Single Phase Transformers

A single phase load is supplied through a 35kV feeder* with an input impedance of 115 + j380 Ω and a 35kV : 2.4kV non-ideal transformer whose equivalent impedance is 0.2 + j1.21 Ω referred to its low-voltage side. If the load is drawing 180kW at 0.87 pf lead at 2.32kV, determine the following:

a. the single phase circuit diagram
b. the voltage at the high voltage terminals of the transformer
c. the voltage at the sending end of the feeder
d. the P and Q at the sending end of the feeder

**A 35 kV feeder refers to a transmission line that transmits power at the 35 kV range. The voltages at the sending and receiving end are not necessarily equal to 35 kV, but close to it.*

Problem 5 – Three Phase Transformers

Three identical single phase transformers with nameplate ratings of 10kVA 440V : 110V each are connected together to form a three-phase transformer bank. The primary windings of the transformers are connected in Y while the secondary windings are connected in Δ. If the transformer primary is supplied by a 700 V source, determine the following:

a. the schematic diagram of the primary and secondary windings of the 3-phase transformer: label the phases and indicate the polarity marks if V_{an} lags V_{AN} by 30°, V_{bn} lags V_{BN} by 30°, and V_{cn} lags V_{CN} by 30°**. Assume an acb phase sequence.
b. the nominal line to line voltage at the secondary
c. the maximum real power that can be supplied to a 0.866 pf lag load at the secondary
d. the maximum secondary current that the transformer can supply to a load
e. the line current drawn at the transformer primary if a Y-connected three phase load with a per phase impedance of 2 + j2 Ω is connected at the transformer secondary

***Note that the capital letters represent the primary phases whereas small letters represent the secondary phases. Also note that the transformer can be connected in such a way that the phase to neutral voltages are displaced by an angle other than 30°.*

Problem 6 – Superposition

A triangular voltage waveform can be approximated by a summation of sinusoids of specific amplitudes and frequencies, i.e.

$$V_S(t) = \frac{8A}{\pi^2} \sum_{n=odd}^{\infty} \frac{(-1)^{(n-1)/2}}{n^2} \sin\left(\frac{n\pi t}{T}\right) \quad Volts$$

where n ϵ {1, 3, 5, 7, 9, …}, A is the amplitude, and T is the period of the waveform.

Using n ϵ {1, 3, 5}, A = 1, T =2, and the circuit shown below, determine the following:

a. the voltage supplied by the source as function of t
b. the sketch of the source voltage for 0<t<10 (you may use a plotting software for this)
c. the voltage across Z_2 as function of t
d. the current through Z_2 as function of t