School of Engineering
Department of Electrical and Computer Engineering

332:494:01/599:02 – Smart Grid – spring 20121
Homework Assignment – Set 1

General guidelines for homework assignments: Homework should be submitted online (via Canvas under the 'assignment' Homework 1)

Question 1:

For the **single-phase** system in Figure 1, it is given that the load Z_{Load} is consuming $16kVA$ at a $pf = 0.6\ leading$. The voltage across the load $\boldsymbol{V}_{Load} = 120\angle 0^{\circ} V(rms)$. The line impedance is $Z_{Line} = 1 + j2\Omega$

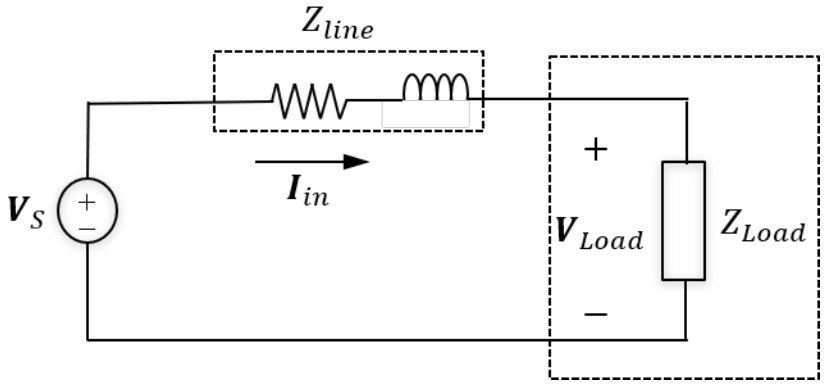


Figure 1

(a) For the load impedance, Z_{Load}, draw the power triangle and find (**include units** for each of the first three values): P_{Load}; Q_{Load}; $|S_{Load}|$; S_{Load} and the power factor angle θ_{pf}

(b) Find the load impedance: Z_{load}

(c) Find the power losses on the line impedance $S_{line}(Z_{line})$

Question 2:

Given the single-phase system in Figure 2, given that:

- $V_{Load} = 13{,}800\angle 0^{\circ} V_{rms}$
- Load 1: 60kW at 0.8 power factor **lead;**
- Load 2: 160 kVA at 0.5 power factor **lag**;

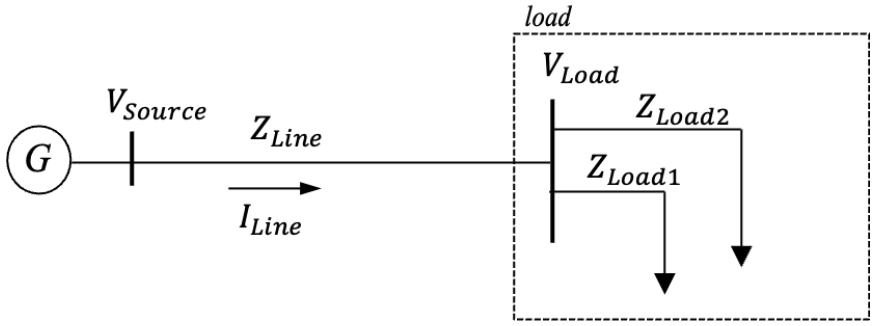


Figure 2

(a) Find and draw the power triangle for load Z_{Load1}: what is the real power P_{Load1} and reactive power Q_{Load1} consumed by load Z_{Load1}

(b) Find and draw the power triangle for load Z_{Load2}: what is the real power P_{Load2} and reactive power Q_{Load2} consumed by load Z_{Load2}

(c) Find the power factor (*pf*) for the total load $Z_{Load\_eq} = Z_{Load1}||Z_{Load2}$ and the total apparent power $|S_{Load\_eq}|$ in Figure 3

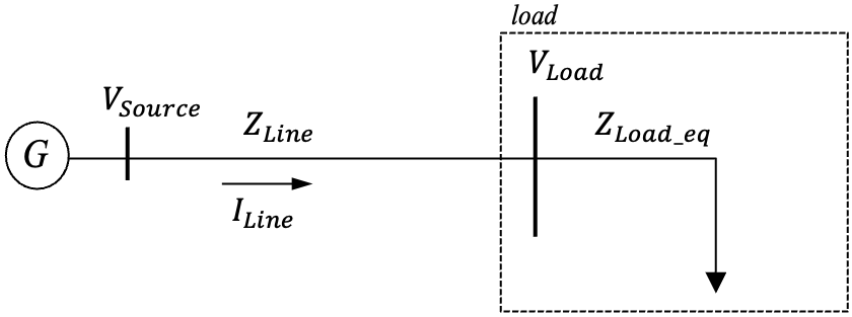


Figure 3

(d) Find the line current phasor $\mathbf{I}_{line}$

(e) A capacitor is added in parallel to Z_{Load_eq} (see figure 4). If the power grid frequency is *f*=60Hz, calculate the size of the capacitor C_{comp} required in order to correct the power factor for the load to 0.95 lag

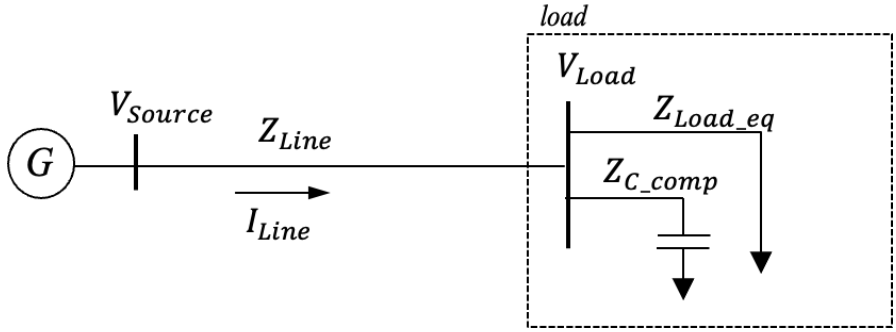


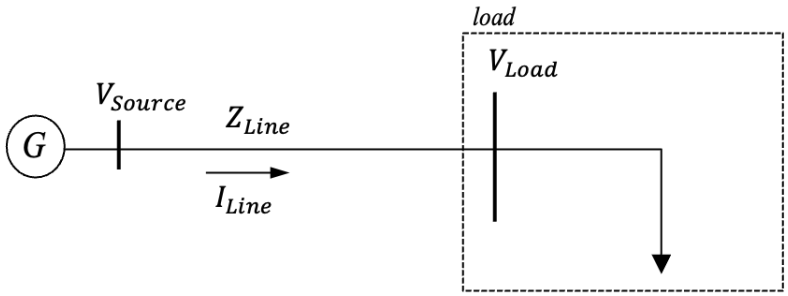
Figure 4

Question 3:

A small manufacturing plant is located 3km down a transmission line, which has a series reactance of j0.4 Ω/km. The line resistance is negligible. The plant is a three-phase load with a line voltage of 690V (Assume a positive sequence and a phase voltage V_{an} that serves as reference with angle ∠0°). It consumes 200 kW at 0.85 power factor lagging.

(a) Determine the line voltage at the source

(b) Determine the 3-phase complex power generated by the source



Question4:

The following three-phase loads are connected in parallel across a 3,800 V (line-line; (Assume a positive sequence and a phase voltage V_{an} that serves as reference with angle ∠0°) balanced three-phase power network:

Load 1: 120 kVA at 0.9 power factor lag;

Load 2: 180 kW at 0.55 power factor lead;

Load 3: 30 kW at unity power factor.

(a) Find the total complex power of the three loads

(b) Find the overall power factor

(c) Find line current in the supply line