EE2022 Electrical Energy Systems

Experiment 1

Title: Complex Power & Power factor improvement

1. Aim

This experiment familiarizes students with the concept of complex power, power factor and power factor (p.f) correction. The aim of this experiment is

- To calculate and compare the complex power of a given laboratory scale power system from the measurements of voltage, current, real power and reactive power.
- To measure the p.f of the given laboratory scale power system and to verify that the p.f can be improved by the addition of capacitors in parallel with the load.

2. Equipments:

2.1. Transformer – 230/20V, 50Hz – 1 Set

2.2. Transmission line model -a resistor (1.2 ohms) and an inductor (2.2 mH)

2.3. Loads – (16.5 ohms,92.6mH and 33 ohms,26mH) – one no. each

2.4. Multimeter

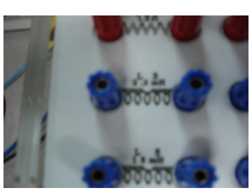
2.5.CW240 Power meter

2.1 Transformer

2.2 Transmission line model

2.3 Transmission line

1.2Ω & 2.2 mH

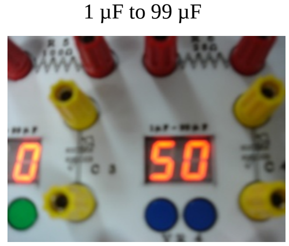


2.3 Transmission line

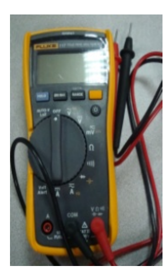
0.H to 0.3H

2.3 Transmission line

1 μF to 99 μF



2.6 Multimeter



2.6 Power-meter

3. Safety

(a) You will be working with electric power. To avoid electric shock, connecting circuits is permitted only after power has been disconnected. **Circuits must be inspected by the lab demonstrator before they are powered on.**

(b) Always choose sufficiently long leads, do not connect two or more short leads to make one long lead. Remove disconnected leads from the bench.

(c) Transformers, inductors, resistors and power supplies are quite heavy. The laboratory does not require that this equipment is moved.

4. Log book report

Each student must submit an individual report after the completion of this experiment. A good laboratory is concise while providing enough details about the experiment. Use the following guide for your report presentation.

Title: Provide the title of the lab exercise along with your name and date the experiment was performed.

Objective: Briefly state the objective of the experiment.

Measurements/results: You will be required to make various measurements and observations. In certain cases you will be comparing theoretical values with those measured, or two different measurements of the same quantity. Most measurements will contain some error (difference between theoretical and measured values). Record these readings and the percent error in the form of a table. Show all calculations.

Discussion and Conclusion: In this section you are able to state whether the objectives of the experiments were met. Were there any errors in measurements that you could not account for?

A good lab report should provide comments and observations to indicate your understanding. Your lab reports should not contain the degree of detail as present in the lab manual, nor should you simplify rephrase what is in the lab manual. Try to keep your reports as concise as possible without deleting essential information.

Important:

Students are warned that copying of lab reports a serious offence which may lead to expulsion from the University. The lab officers have been instructed to confiscate all copies of lab reports not belonging to the students concerned during the lab sessions.

5. Ratings:

Power equipment is designed by the manufacturer to operate in a certain range of voltages and currents. The parameters quoted by the manufacturer are known as the rating of the equipment. Operating the equipment at voltage or current higher than the rated voltage and current is unsafe and may damage the equipment. These ratings must not be exceeded at any time during the laboratory exercises.

6. Experimental procedure

Warning: Do not make any connections with power on! Have your circuits checked by the laboratory demonstrator before turning on the supply:

6.1 Complex Power

(a) Connect the circuit as shown in figure 1. **Have your circuit checked by the laboratory demonstrator.** Switch on the power meter and the power supply. Use the power meter to measure the load voltage (V), load current (I), load p.f (P.F), real and reactive power consumed by the load (P & Q) and record the values in Table 1. Also use the multimeter to measure the voltage across load inductor. Using this voltage and current indicated by the power meter **calculate the inductance and verify the load inductance value indicated on the circuit diagram.**

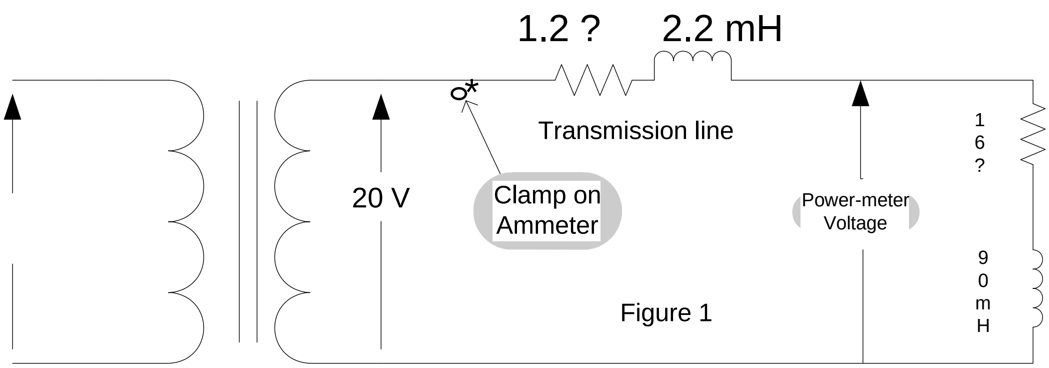


Figure 1

(b) Replace load in figure 1 with R=33Ω and L=26mH. **Have your circuit checked by the laboratory demonstrator.** Switch on the power meter and the power supply. Repeat the measurements as in step 6.1a and record the values in Table 1.

(c) Connect the circuit as shown in figure 2. **Have your circuit checked by the laboratory demonstrator.** Switch on the power meter and the power supply. **Use the power meter to measure the voltage (V), current (I), p.f (P.F), real and reactive (P & Q) power on the receiving end and record the values in Table 1.**

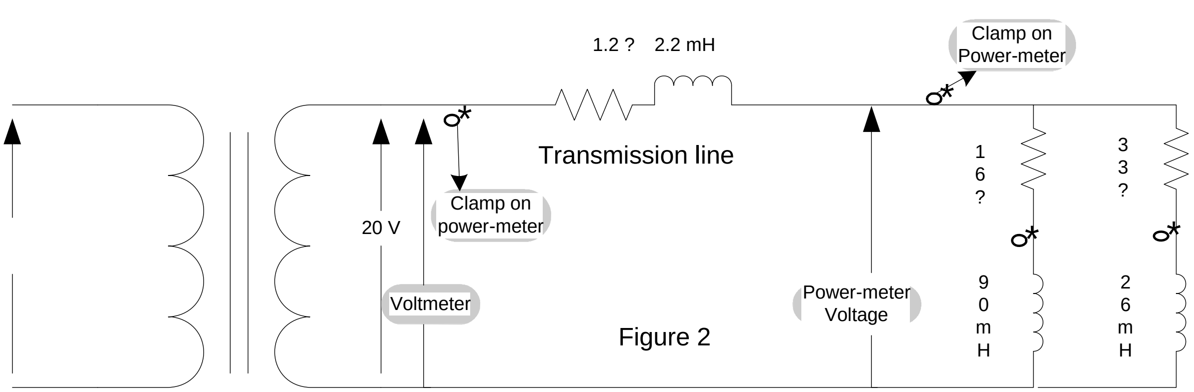
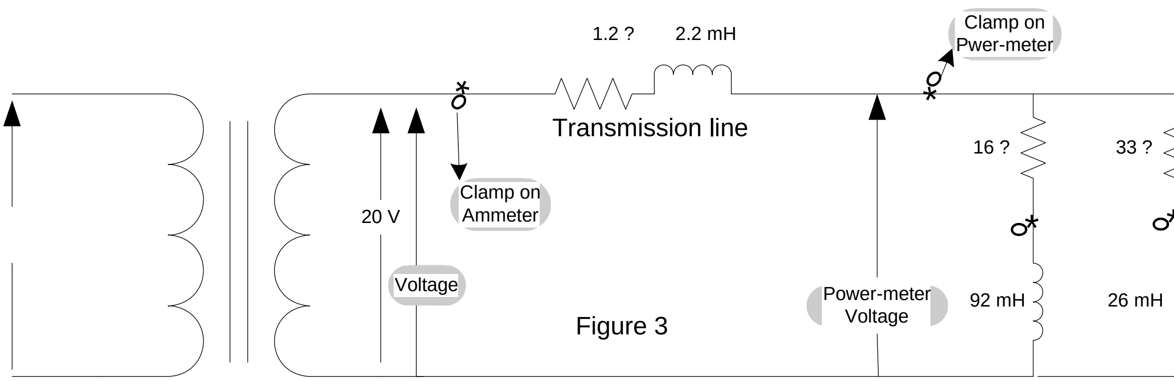


Figure 2

(d) Connect the circuit as shown in figure 3. **Have your circuit checked by the laboratory demonstrator.** Switch on the power meter and the power supply. **Use the power meter to measure the voltage (V), current (I), p.f (P.F), real and reactive (P & Q) power on the sending end and record the values in Table 1.**



6.2 Power factor improvement

(a) Calculate the value of capacitance required to improve the p.f found in step 6.1.c to unity. Connect the circuit as shown in figure 4. Switch on the required capacitance as calculated. **Have your circuit checked by the laboratory demonstrator.** Switch on the power meter and the power supply. Repeat the measurements as in step 6.1.c and record the values in Table 1.

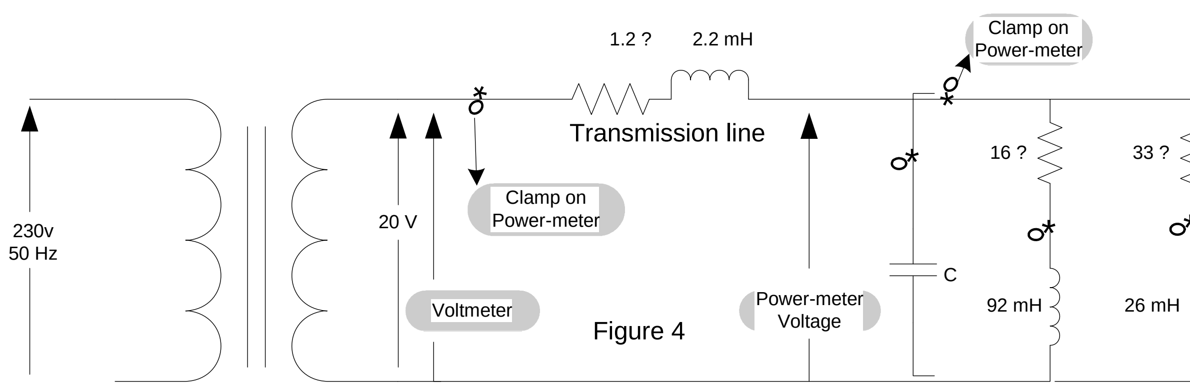


Figure 4

(b) **On/off the switches on the capacitor bank in figure 4 to set the capacitance value as 30µf. Repeat the measurements as in step 6.1.c and record the values in Table 1.**

Table 1: Measurements

Step	V (volt)	I (A)	P (W)	Q (var)	P.F	$\theta = COS^{-1}(P.F)$	Complex (Apparent) power (VA)		
							S=P+jQ	S=|S|< θ	S=VI*
6.1.a									
6.1.b									
6.1.c									
6.1.d									
6.2.a									
6.2.b									

Note: Complex power values calculated in column no. 9 (S=|S|< θ) & 10 (S=VI*) should be same for each step.

7. Report

(a) Make the necessary calculations and produce the completed table 1 shown above.
(b) Draw the power triangle for all the six steps with the values indicated in proper units.
(c) Compare and comment on the complex power values in step 6.1.c and 6.1.d. Your discussion should include the components of complex power.
(d) Why the rating of some of electrical apparatus represented in VA (unit of apparent power) instead of watts.
(e) Show the detailed steps of calculations involved in section of 6.2.a.
(f) Theoretically (perform calculations) confirm the value of p.f indicated by the power meter in step 6.2.b.
(g) Compare and comment on the real and reactive power values recorded in step 6.1.c and 6.2.a.
(h) Explain the effect of capacitor on the reactive power.
(i) What would happen if you connect the capacitor with the value more than the calculated value in step 6.2.a.
(j) Name any two practical examples of electrical loads which work on unity power factor.