EE 205 Circuit Theory

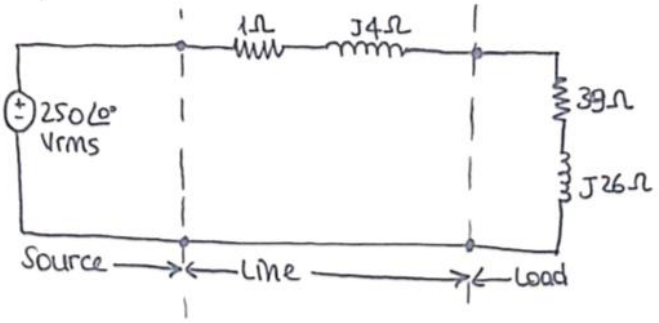
Lab 3

Complex Power Analysis

The aim of this lab is find the complex power in a given circuit.

Consider the example circuit given below. We have already solved this question in the previous lecture. Here, we want to verify the calculated results with the Proteus simulations.

Ex: Given the circuit,



Calculate

a) The load current $\bar{I}_L$ and voltage $\bar{V}_L$

b) The average and reactive power delivered to the load.

c) The average and reactive power delivered to the line

d) The average and reactive power supplied by the source.

- Solution:

a) $\underline{I}_L = \dfrac{\underline{V}_{source}}{\underline{Z}_{total}} = \dfrac{250\angle 0^\circ}{40+j30} = \boxed{4-j3\ (A)} = 5\angle -36.87^\circ\ A\ (rms)$

($\underline{Z}_{total}$: series impedence)

$\underline{V}_L = (39+j26)\,\underline{I}_L = \boxed{234-j13\ (V)} = 234.36\angle -3.18^\circ\ V\ (rms)$

b) $S = V_L I_L^* = (234-j13)(4+j3) \Rightarrow S = 975+j650\ VA$

Thus, the load absorbing average power of 975 W and reactive power of 650 VAR

c) $P = |I_{eff}|^2 R = (5)^2(1) = 25W$

$Q = |I_{eff}|^2 X = (5)^2(4) = 100VAR$

d) $S = \underbrace{25+j100}_{S_{line}} + \underbrace{975+j650}_{S_{load}} \Rightarrow S_{source} = -1000 - j750\ VAR$

$P_{source} = -1000\ W$, $Q_{source} = -750VAR$

Procedure:

1. Draw the following circuit:
   Remember the values for the inductors have to evaluated beforehand.

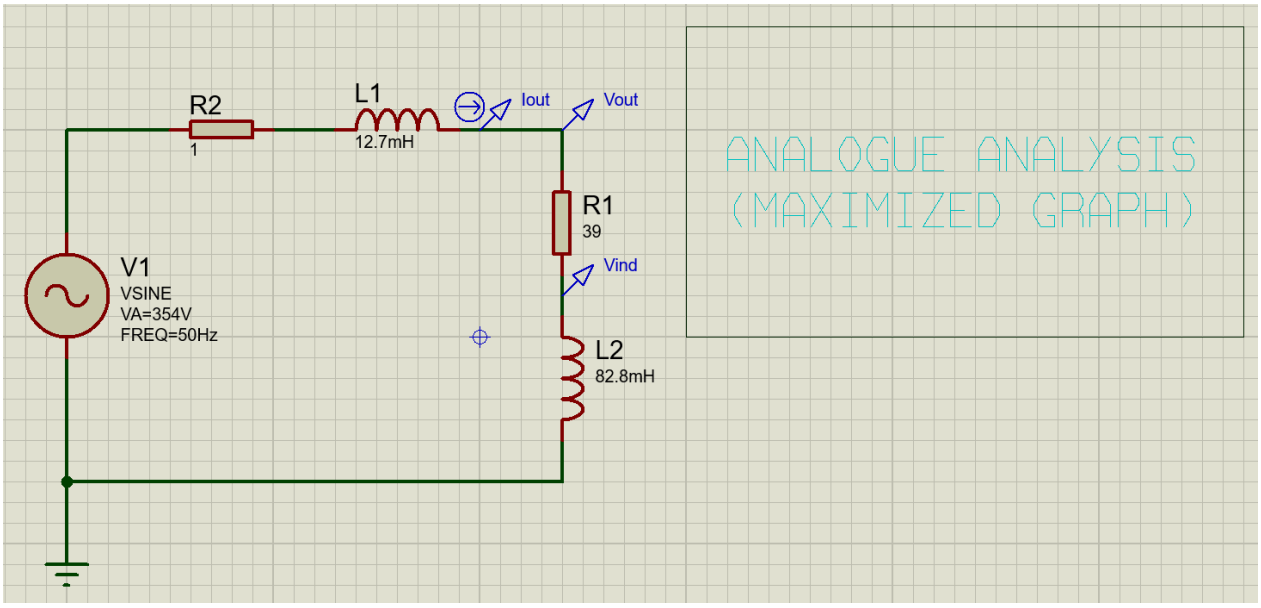


Fig.2. Circuit schematics

2. Place voltage and current probes as shown in Fig.1.
3. Place a graph on to the design page.
4. Right click the empty graph and select “add trace” option.
5. Select probe P1, P2, and P3 as the Iout, Vout and Vind respectively. Also, give it a name “Inst. power at R1”. In the expression box, type “P1*(P2-P3)”, and hit “ok”.
6. You should see the instantaneous power across the resistor R1. To find its average, we need to see its amplitude. So, maximize and click on the graph, and move the cursor to its peak. Read the amplitude and divide it by 2. Record this average power in the Table below.

Table 1. Load average power

Pavg for load (calculated)	Pavg for load (simulated)
975W	

7. Do similar steps for measuring the reactive power Q. This time you must multiply the current by the inductor voltage and plot the instantaneous power across the load inductor. The peak value of this graph is the reactive power.

Table 2. Load reactive power

Q for the load (calculated)	Q for the load (simulated)
650 VAR	

8. Draw the power triangle for the load. Find apparent power A. Find the power angle $\theta = \theta_v - \theta_i$, and the power factor $pf = \cos(\theta)$. Record them into the table below.

Table 3. power angle and power factor for the load

A	θ	pf

Power triangle: