AC Maximum Power Transfer

EEL 3112C – Circuits-II
Lab Experiment

Dr. Suleiman Alsweiss

ECE Department

Florida Polytechnic University

Objective

- In this exercise, maximum power transfer to the load will be examined for the AC case
- Both the load’s resistive and reactive components will be independently varied to discover their effect of load power and determine the values required for maximum load power

Theory Overview

- In the DC case, maximum power transfer is achieved by setting the load resistance equal to the Thevenin equivalent resistance
- For the AC case, the load should be set to complex conjugate of the Thevenin equivalent impedance ($\boldsymbol{Z_L = Z_{Th}^*}$)
  - The complex conjugate having the same magnitude as the original but with the opposite sign for the angle
  - By using the complex conjugate, the load and source reactive components will cancel out leaving a purely resistive circuit similar to the DC case
  - When calculating the true load power average power, only the real part of the load impedance dissipates power

$$\boldsymbol{P_{max} = \left|I_{Th_{rms}}\right|^2 R_L = \frac{\left|V_{Th_{rms}}\right|^2 R_L}{4R_L^2} = \frac{1}{8}\frac{V_{peak}^2}{R_L}}$$

Components

Component name	Quantity	Value	Measured value
Resistors	2 1 1 1 1	1 KΩ 3 KΩ 10 KΩ 100 Ω 600 Ω	
Inductor	1	$10\ mH$	
Capacitor	4 1 1	$0.1\ \mu F$ $10\ nF$ $47\ nF$	

Schematics

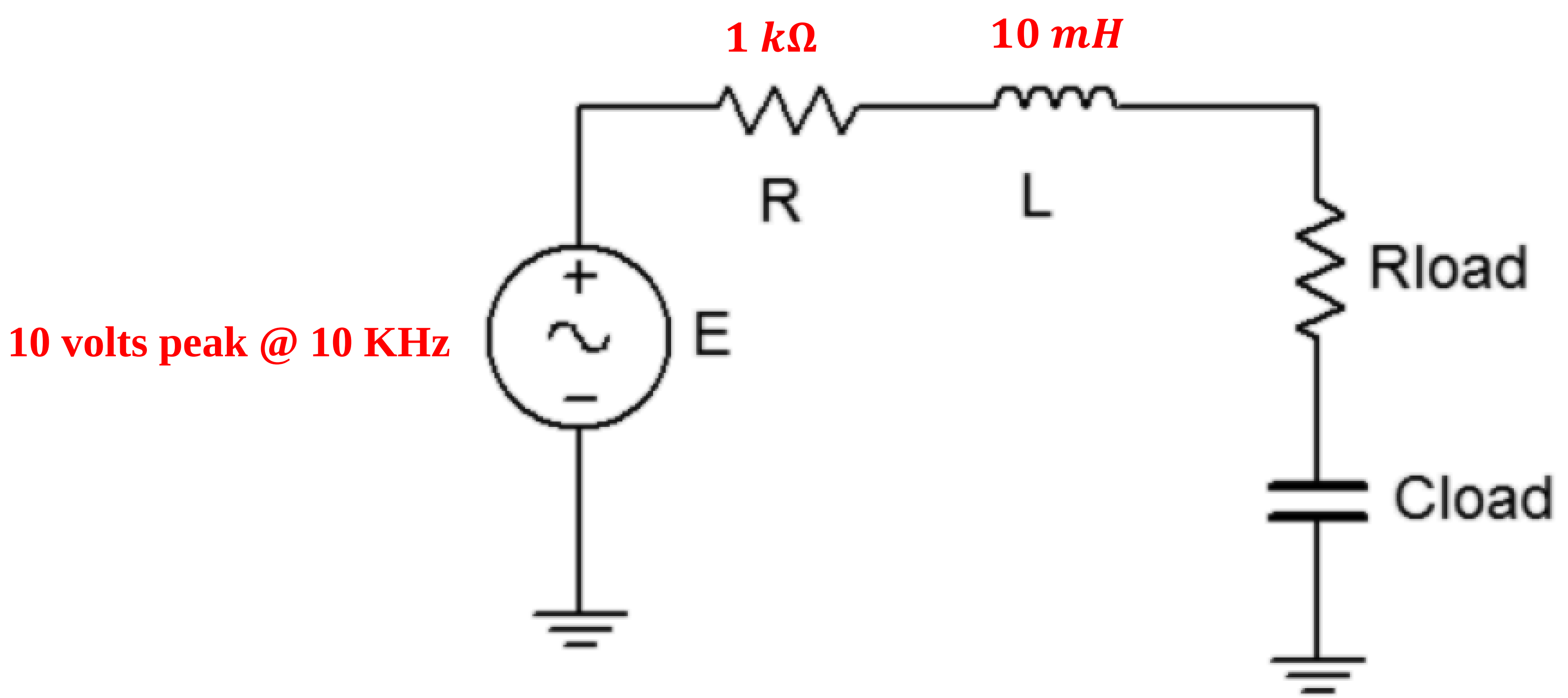

Figure 1

Procedure: Step 1

- For the circuit shown in Fig. 1, calculate the following:
  a) The value of the load impedance that will guarantee maximum power transfer
  b) The value of the resistor needed to realize that circuit
  c) The value of the capacitor needed to realize that circuit

- Record your answers in table 1

Procedure: Step 1 – cont.

Table 1

Quantity	Value
Z_{Th}	
Z_{load} for max power transfer	
R_{load} for max power transfer	
C_{load} for max power transfer	

Procedure: Step 2

- Use the value of C_{load} you calculated in Table 1 to fill Table 2 using the resistors values provided in the table

Note 1: $V_{load_{Theory}} = V_{Th} \times \frac{R_L}{R_L + R_{Th}}$

Note 2: $V_{load_{Experimental}}$ is the voltage across R_L

Note 3: $P_{load_{Theory}} = \frac{\left(V_{laod_{Theory_{rms}}}\right)^2}{R_L}$

Note 4: $P_{load_{Experimental}} = \frac{\left(V_{load_{Experimental}}\right)^2}{R_L}$

Procedure: Step 2 – cont.

Table 2

R_{load} (Ω)	V_{load} Theory	V_{load} Experimental	P_{load} Theory	P_{load} Experimental
100				
600				
1000				
3000				
10,000				

Procedure: Step 3

- Use the value of R_L you calculated in Table 1 to fill Table 3 using the capacitors values provided in the table

Note 1: $V_{load_{Theory}} = V_{Th} \times \frac{R_L}{R_L + R_{Th}}$

Note 2: $V_{load_{Experimental}}$ is the voltage across R_L

Note 3: $P_{load_{Theory}} = \frac{\left(V_{laod_{Theory_{rms}}}\right)^2}{R_L}$

Note 4: $P_{load_{Experimental}} = \frac{\left(V_{load_{Experimental}}\right)^2}{R_L}$

Procedure: Step 3 – cont.

Table 3

C_{load}	V_{load} Theory	V_{load} Experimental	P_{load} Theory	P_{load} Experimental
$10\ nF$				
$47\ nF$				
$0.1\ \mu F$				
$0.247\ \mu F$				
$0.4\ \mu F$				

Procedure: Step 4

- Generate a plot of P_{load} (experimental and theoretical) with respect to R_{load} and another one for P_{load} (experimental and theoretical) with respect to C_{load}

- Comment on your plot

Questions

Q1) In general, given a certain source impedance, what load impedance will achieve maximum load power?

Q2) If the experiment was repeated using a frequency of 5 kHz, how would the graphs change, if at all?