Lab 9: AC Thevenin Equivalent

Purpose:
Introduce Thevenin Equivalent circuits for sinusoidal steady state.

Equipment and Components:
1) Prototyping board, Multimeter, Power supply, Signal Generator, Oscilloscope.
2) Resistors (3): 1 kΩ.
3) Capacitors (1): 1 μF.
4) Inductor: 1 mH (look into parts bin in ET139 if not available in ET101A) and others as necessary.

Procedure:

1. Calculation
(a) Calculate the Thevenin equivalent circuit given a 1 Volt amp 500Hz sinusoidal source.
(b) Calculate the type of load required to enable maximum power transfer to the load. Specify the components for a series equivalent load. See section 10.6 (page 378) for help.
(c) Draw the Thevenin circuit with this load and calculate the amplitude of the current flowing through the load (note: impedances of reactive components will cancel out).
(d) What is the maximum ave power transferred to the load? Remember: \( V_{rms} = 0.707V_{max}, I_{rms} = 0.707I_{max} \).

2. Simulation
(a) Verify your Thevenin equivalent calculation using simulation from Multisim or LTSpice. Leave the end terminals open for \( V_{TH} \) (For \( Z_{TH} \), assume that your calculation is correct).
(b) Verify that the load from calculation will provide a maximum power transfer using simulations from Multisim or LTSpice. This can be done by probing the current through the load. Check to see if this amplitude value matches the one you calculated before. Make sure to enter the exact value for the load.
(c) What is the maximum power transferred to the load? Does it match your calculation?
(d) If the frequency of the source is increased to 50 kHz in the simulation, does the load still enable maximum power transfer? If not what would have to be changed?

3. Experiment
(a) Construct the circuit in Figure 1 and conduct the following:
   (1) With the signal generator connected to the circuit, attach probe 1 of the oscilloscope to its output and adjust the function generator to produce a 1 Volt 500 Hz sinusoidal signal.
   (2) Measure both the magnitude and phase of \( V_{oc} = V_{TH} \). For \( V_{TH} \), leave the output terminals of the circuit open. For \( Z_{TH} \), assume that your calculations are correct.
(b) Construct the matched load that you calculated & simulated.
(c) Verify that this load provides a maximum power transfer at 500 Hz. First, measure rms voltage and rms current across the load using multimeter (~ button on the multimeter). Then find power. This value should match the calculated and simulated values.
(d) Now change the frequency of the source to 50 kHz. Observe the differences in the power transfer to the load (you may find it difficult to measure the \( I_{rms} \) so approximate it as best as you can). How can you improve the power transfer at this frequency?

Conclusion
Compare your calculated, simulated and measured values for power in a table. Give plausible reasons for the discrepancies.