ECEN 214-302 – Electric Circuit Theory

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Summer 2020

Lab 9: Power Transfer in AC Circuits

**Submitted by:**

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| **Table 1.** UIN, names, and section numbers. | | | |
| **Student Name** | **UIN** | **Section #** | **Group #** |
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**Date Performed: August 2, 2020**

**Due Date: August 3, 2020**

**TA: Chen Gong**

1. Objective

The objective for each task of the report is to maximize power delivered by first varying the resistive load then the shunt capacitance independently then optimize them both to maximize the power delivered to the load resistor.

1. Procedure

**Materials**

* Breadboard
* PMD
* Computer with Waveforms program
* USB cord
* Various color wires
* 1 – 2.2kΩ Resistor
* 1 – 0.12H Inductor
* Various Capacitors
* Various Resistors
* Function Generator
* Oscilloscope

**Setup**

1. Collect materials above onto a table.
2. Connect USB cord to computer and PMD.
3. Open Waveforms program and open the Wavegen and Voltmeter windows.

**Task One – Max Power Transfer with a Purely Resistive Load**

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1. Use the Wavegen for the input voltage and put the peak-to-peak voltage to 8 volts with a frequency of 10kHz.
2. Connect the input voltage to a 2.2kΩ resistor then connect that resistor to a 0.12 H inductor. As seen in Figure 9.5.
3. Collect resistors 4kΩ, 6kΩ, 8kΩ, 10kΩ, 15kΩ, and 20kΩ and swap these resistors with and measure the voltage across the resistor.
4. Record the load voltage with the load resistor and record the current of the load resistor.
5. Plot the recorded data in plot of v.s .

**Task Two – Improving Power Transfer with a Shunt Capacitor**

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1. Use the Wavegen for the input voltage and put the peak-to-peak voltage to 8 volts with a frequency of 10kHz.
2. Connect the input voltage to a 2.2kΩ resistor then connect that resistor to a 0.12 H inductor. As seen in Figure 9.6.
3. Choose a that maximize that load power and place in parallel with the shunt capacitor.
4. Swap the capacitors 0.5nF, 0.8nF, 1nF, 1.5nF, 2nF, 3nF, and 4nF in and out in parallel and measure current and voltage of the load resistor.
5. Plot using the measured data.

**Task Three – Optimal Power Transfer**

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1. Use the Wavegen for the input voltage and put the peak-to-peak voltage to 8 volts with a frequency of 10kHz.
2. Connect the input voltage to a 2.2kΩ resistor then connect that resistor to a 0.12 H inductor. As seen in Figure 9.6.
3. Choose a selection of capacitors (0.5nF, 0.8nF, 1nF, 1.5nF, 2nF, 3nF, and 4nF) and a selection of resistors (4kΩ, 6kΩ, 8kΩ, 10kΩ, 15kΩ, and 20kΩ) and choose the load resistor and the shunt capacitor to maximize the delivered power to the load resistor. Record the values used to maximize the power.
4. Difficulties

I had a lot of trouble with finding the right combination of capacitors of series and parallel to get the 3nF and the 4nF capacitor.

1. Results

**Task One – Maximum Power Transfer with a Purely Resistive Load**

|  |  |  |
| --- | --- | --- |
| **Table 1.** Power Measured on Load with Varying Resistance. | | |
|  | (mV)rms |  |
| 4 | 196 | 4.8 |
| 6 | 257 | 5.5 |
| 8 | 301 | 5.66 |
| 10 | 333 | 5.54 |
| 15 | 383 | 4.89 |
| 20 | 410 | 4.20 |

**Figure 1.** Relationship for Load Power and Load Resistance for Task One.

**Task Two – Improving Power Transfer with a Shunt Capacitor**

= 8kΩ

|  |  |  |
| --- | --- | --- |
| **Table 2.** Power Measured on Load with Varying Capacitance. | | |
| C(nF) | (mV)rms |  |
| 0.5 | 326 | 6.64 |
| 0.8 | 348 | 7.57 |
| 1 | 358 | 8.01 |
| 1.5 | 374 | 8.74 |
| 2 | 365 | 8.33 |
| 3 | 358 | 8.01 |
| 4 | 349 | 7.61 |

**Figure 2.** Relationship between Shunt Capacitance and Load Power

**Task Three – Optimal Power Transfer**

|  |  |  |
| --- | --- | --- |
| **Table 3.** Load Power with Resistive load and Shunt Capacitance optimized. | | |
| (Ω) | (mV)rms | (μW) |
| 7,857 | 360 | 8.25 |

C = 2nF,

1. Discussion

**Task One**

The theoretical load resistance to maximize the power delivered to the load is 7,854Ω. The load resistance used is 8,000Ω because it generated the maximum load power and is closest to the theoretical value. The best load resistance is 8,000Ω because it has the highest measured load power and is closest to the theoretical load resistance that maximizes the load power.

**Task Two**

The power delivered to the load resistor increases by about 50% with the shunt capacitor compared to the circuit without the capacitor. The capacitor that was found to produce the largest load power delivered is 1.5nF which is the same as the calculated theoretical capacitance.

**Task Three**

The load power is very different from task one to task two because the shunt capacitor adds voltage to the circuit that increases the voltage on the load resistor therefore having a higher load power on the load. Task three I chose the capacitor and load resistor that would maximize the load power which is close to the load power from task two. The optimization has little affect to the load power.

1. Conclusion

In the experiment the power delivered to the load resistor was maximized each time by varying different components to observe how changing certain components gives varying delivered power. The results showed that varying the load resistor or capacitor independently while keeping the other the same had minimal changes but optimizing both values maximized the power delivered to a large amount. I used a lot of individual resistors for task three so the tolerances of each resistor should have a noticeable effect on the accuracy of the measured power. I wonder if power rebounds on task one if the load resistance was changed to a series of values below 2kΩ.