

ELEX 3120/3321: Electric Circuits 2

LAB 8 – Second Order

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# Introduction

This lab is to investigate the behavior of second-order circuits, focusing on their frequency response, step response, and conditions for achieving critical damping. By determining the transfer function of the circuit, we predicted its performance analytically and validated these predictions through experimental measurements and simulations in LTSpice. The study aimed to deepen our understanding of second-order system dynamics and their practical implications in electronics.

# Experiments



Figure 1 - RLC circuit LTSpice Schematic

## Frequency Response

A graph of a wave

Description automatically generated with medium confidence

Figure 2 - LTSpice Simulation of Frequency Response

Figure 3 - Measured and Predicted Gain and Phase Plot

|  |  |  |
| --- | --- | --- |
| Frequency (Hz) | Measured Gain(dB) | Measured Phase |
| 1.0E+00 | -2.64E+01 | -0.107 |
| 5.0E+00 | -1.25E+01 | -0.118 |
| 1.0E+01 | -6.44E+00 | -0.203 |
| 5.0E+01 | 7.54E+00 | -0.557 |
| 1.0E+02 | 1.36E+01 | -0.4715 |
| 5.0E+02 | 2.75E+01 | -5.203 |
| 1.0E+03 | 3.36E+01 | -11.75 |
| 4.0E+03 | 4.56E+01 | -64.2 |
| 4.5E+03 | 4.66E+01 | -75.3 |
| 4.7E+03 | 4.70E+01 | -81.1 |
| 5.0E+03 | 4.75E+01 | -101.7 |
| 6.0E+03 | 4.91E+01 | -110.2 |
| 6.7E+03 | 5.01E+01 | -123 |
| 7.0E+03 | 5.05E+01 | -124.3 |
| 7.5E+03 | 5.11E+01 | -130.2 |
| 1.0E+04 | 5.36E+01 | -152.2 |
| 5.0E+04 | 6.75E+01 | -174.4 |
| 1.0E+05 | 7.36E+01 | -176.2 |
| 5.0E+05 | 8.75E+01 | -179 |
| 1.0E+06 | 9.36E+01 | -179.9 |

Table 1 - Measured Frequency Response Data

## Step Response

**Underdamped**

A graph with a line

Description automatically generated

Figure 4 - LTSpice Simulation of Step Response

Figure 5 - Predicted and Measured Step Response Plot

## Critical Damping

A screen shot of a graph

Description automatically generated

Figure 6 – Critical Damping

|  |  |  |
| --- | --- | --- |
|  | Predicted | Measured |
| Rcritical | 622 | 547 |

Table 2 - Predicted and Measured Critical Damping Resistance

# Conclusions

In this lab, we successfully demonstrated the behavior of second-order circuits under various conditions, including frequency and step inputs. The experimentally measured responses closely aligned with the predicted values, confirming the accuracy of the theoretical models and simulations. Additionally, achieving critical damping showcased the practical tuning required to eliminate overshoot in system responses. These findings highlight the importance of precise parameter adjustments in optimizing circuit performance.