Experiment 5

**Submission Template**

# The following should be included in your experimental checklist. Everything should be labeled and easy to find. Credit will be deducted for poor labeling or unclear presentation. ALL PLOTS SHOULD INDICATE WHICH TRACE CORRESPONDS TO THE SIGNAL AT WHICH POINT AND ALL KEY FEATURES SHOULD BE LABELED.

**Hand written schematics are required for physically built circuits, ONLY!!!**

# Part A – (16 pts)

A.1 Nothing to plot. (0 pts)

A.2

1. Plot of Vleft - Vright with R4 modified. (1 pt)
2. Fraction of output signal compared to Vac source. (2 pt)

A.3

1. Analysis of circuit in part A.2. (2 pt)
2. Derivation of formula for Vout = dV (= Vleft – Vright) as a function of R4, V1, ... (2 pt)

A.4

1. Plot of all 11 Vout traces. (2 pt)
2. Plot of just Vright for all 11 cases. (1 pt)
3. Comment on the advantage of using a bridge (Vleft - Vright) vs. using just a divider (Vright). (2 pt)

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**A.5**

1. What is the sensitivity of this circuit (change in Vout/change in R)? (4 pt)

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# Part B – (16 points)

B.1 Include the following plots:

1. B.1 Min and Max resistance measured. (2 pt)

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1. B.2 Nothing.
2. B.3 Voltage measurements for three beam positions. (3 pt)
3. B.4 Analog Discovery plot of beam oscillation with calculations of beam frequency and damping constant on it. (6 pt)

B.2 Answer the following questions:

1. What is the resonant frequency of the beam? What value did you find for the damping constant? Write an equation for the decaying sinusoid output of the beam in the form v(t)=Ce-αtsin(ωt). (5 pt)

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# Part C – Instrumented Beam as a Harmonic Oscillator (18 points)

C.1 Include the following plots:

1. Two M2k/Analog Discovery plots of the decaying sinusoid obtained with different masses added. For each write the mass added and the frequency measured. Have a TA or instructor sign and date the plots. (4 pt)
2. A table such as the one on page 10 of this document, listing the mass, total mass and frequency. 2pt)

1. Excel plot of frequency vs. load mass with four points marked. (3 pt)

C.2 Answer the following questions:

1. Explain or show your work on how you did your analysis to determine a reasonable first guess for k and m. (2 pt)

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1. What are the values for k and m that you obtained by making the plot in Excel? (2 pt)

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1. Calculate the mass of the beam. (2 pt)

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1. Calculate Young’s Modulus for the beam. Clearly indicate the values you measured for the beam’s dimensions. (2 pt)

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1. What do you conclude the beam could be made of? Why? (3 pt)

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# Part D – Oscillating Circuits (20 points)

D.1 Include the following plots:

1. PSpice plot of input and output from the oscillating circuit. Be sure to label your plot with the resonant frequency and damping constant of the circuit you analyzed using the PSpice plot. Write an equation for the output in the form v(t)=Ce-αt sin(ωt). (4 pt)
2. M2k/Analog Discovery plot of input and output from the oscillating circuit. Again, be sure to determine the resonant frequency and damping constant and include this information on your plot. (4 pt)
3. PSpice plot of the energy in the inductor, the energy in the capacitor and the total energy as functions of time. Be sure to label everything interesting in these plots. (6 pt)

D.2 Answer the following questions:

1. Compare and contrast both your PSpice and Analog Discovery plots with the plots for the cantilever beam. (2 pt)

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1. What value did you calculate for f using the equation for the resonant frequency? How close of an estimate is this to the resonance you found in the plot? (2 pt)

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1. What value did you calculate for α using the equation? How close of an estimate is this to the damping constant you found in the plot? (2 pt)

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**Organization, completeness, ordering. Is this easy to grade? (6 pt)**

**List group member *responsibilities (4 pts)*.**  Note that this is a list of *responsibilities*, not a list of what each partner did. It is very important that you divide the responsibility for each aspect of the experiment so that it is clear who will make sure that it is completed. Responsibilities include, but are not limited to, reading the full write up before the first class; collecting all information and writing the report; building circuits and collecting data (i.e. doing the experiment); setting up and running the simulations; comparing the theory, experiment and simulation to develop the practical model of whatever system is being addressed, etc.

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**Summary/Overview** (0 to -10 pts) There are two parts to this section, both of which require revisiting everything done on this experiment and addressing broad issues. Grading for this section works a bit differently in that the overall report grade will be reduced if the responses are not satisfactory.

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***Experiment 5***

***Checklist w/ Signatures for Main Concepts***

INSERT SIGNED COPY OF CHECKLIST BELOW (OR ADD SCANNED PDF VERSION)

***Experiment 5***

***Hand Drawn Schematics***

INSERT HAND DRAWN SCHEMATICS FOR ALL CIRCUITS BUILT