ECE 207 **Lab Work 10** **Due October 12th**

Names ____

Objectives:

Use a calibrated strain gage-based force measurement system to extract the model parameters for a cantilever beam load cell.

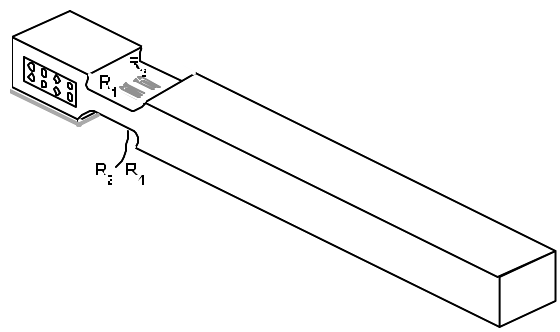
Deliverables

1. Analysis procedure (neatly done) showing the theory and background employed to extract the beam's model parameters from measurement.
2. Completed procedure.
3. The effective mass, damping constant, and spring constant for the cantilever beam extracted from experiment.

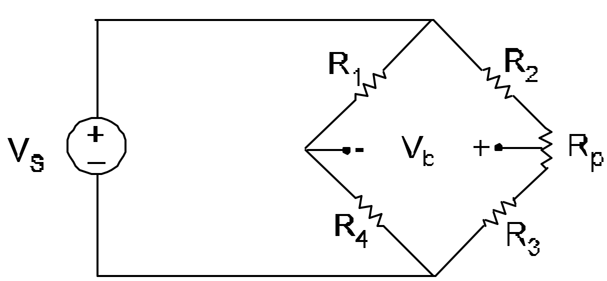
Procedure

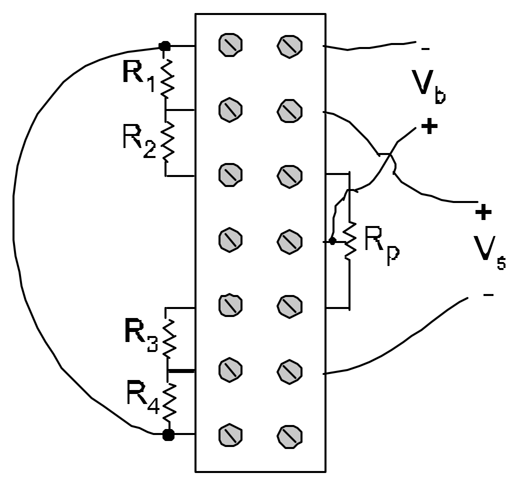
<u>Instrument connection and adjustment</u>

1. Carefully clamp the cantilever load cell to table.



2. Bring V_s = 6V to the Wheatstone bridge. The power supply should be **off** when making connections.



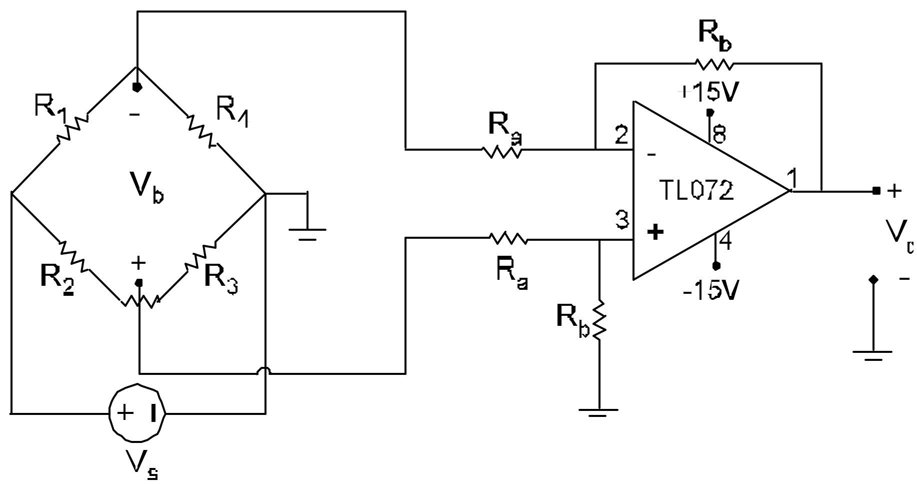


3. Turn 6V supply on. Null the bridge so that $V_b \cong 0V$.

4. Turn 6V supply off.

5. Connect V_b to differential amplifier (gain≅50 with R_a = 2 kΩ and R_b =100 kΩ) As always, turn power supplies **off** when connecting circuit.

ELECTRICAL CIRCUIT



6. Enable circuit by turning on 6V and ±15V supplies. Null the bridge so that $V_o \cong 0V$.

Observation of the natural response

7. Connect V_o to channel 1 of the oscilloscope. Use channel 1 as trigger source.

8. Press single-run mode to arm the oscilloscope for natural response capture.

9. Mount the cantilever beam to the bench without an added weight.

10. Capture the beam's natural response by grasping the beam with your fingers, pulling the beam down, and gently releasing the beam. Adjust the triggering level to until you successfully capture the waveform (start with a triggering level of about 50-100 mV).

11. You may have to repeatedly adjust the time and vertical scales (and recapture natural response each time) to obtain a useful trace of the natural response.

12. After you have captured a useful trace: 1) use scope cursors etc. to measure δ and ω_d and 2) save the trace to disk.

    i) Press **Utility** key, the press the **PrintConfg** softkey to display the print configuration menu.

    ii) The **Print to:** softkey allows one to select printing to disk. The print file will be named *PRINT_nn.xxx*, where *xxx* is the format (BMP, TIF, or CSV). *nn* is the number of the file (starting at *00*).

    iii) The **Format** softkey allows the print format to be selected.

    iv) Press **Quick Print** key to print to disk.

    Save the trace *twice*: 1)as a TIF image and 2)in CSV (comma-separated variable) format, for spreadsheet analysis (for CVS, adjust **length** softkey to 1000)

13. Attach a weight (1 or 2 lbs) to the beam. m_o = ______ lb = ______ kg

14. Capture the natural response as above, this time with m_o attached to the beam. Save trace as a TIF image and in CSV format.

Analysis guidelines

- Show your analysis procedure symbolically (use no numerical data). This will allow you to see the problem in its most uncluttered form.

  Use m, b, and k as the beam's model parameters and m_o as the added weight. Use ω_d as the damped natural frequency and δ as the logarithmic decrement (these parameters are directly obtained from observation). Use ω_n and ζ as the undamped natural frequency and the damping ratio. These derived parameters are then used to extract the model parameters.

- ***Hints***: Use the natural frequencies obtained from trace 1 (without added weight) and trace 2 (with m_o) to obtain values for m and k. Use data for the ω's first since they are likely the most accurate measurements. For lightly damped systems, the damping ratio is the parameter most difficult to measure accurately.

  Using these values for m and k, find b_1 from trial 1 data and b_2 from trial 2 data. Use the average between these two values for the extracted value for b.

- Using experimental data show analysis that extracts m, b, and k using the procedure you outline above. Give the extracted parameters below.

m = ___________ **b =** ____________ **k =** ____________