

ME4005: Lab 3 - Beam Vibration (Lab Manual)

1 Objectives

- To perform a free vibration of a cantilever beam, instrumented with a strain gauge and Wheatstone bridge.
- To use a strain gauge as a dynamic tip displacement.
- To determine beam tip displacement over time, for comparison to theory, using the Wheatstone bridge output.
- To perform a spectrum analysis on the tip displacement (voltage data) to determine the “natural frequencies” of a cantilever beam.

2 Theoretical Topics

- Significance, and methods, of using a strain gauge as a displacement sensor rather than direct measurements.
- Cantilever beam (Clamped-free) theory for vibrations, focusing on the beam response having multiple frequencies.

3 Before you Start

To complete this lab, you will need to do the following:

- Read the lecture notes for this lab *Free Vibration of a Cantilever Beam.pdf*
- Watch lecture recordings posted on Canvas – Media Gallery (course)
 - Beam Vibration Lab Part 1 presents free vibration
 - Beam Vibration Lab Part 2 presents beam theory
 - Beam Vibration Lab Part 3 presents experimental considerations
- Review lecture material/recordings on harmonics, spectrums, and Fourier Transforms.
- Complete the Prelab assignment to complete the required static measurements of the beam.

4 Part 1: Experimental and Data Acquisition (DAQ) Setup

The experimental setup should follow the same setup as in Lab 2: Beam Strain Gauge lab, where the instrumented beam is mounted as a cantilever beam. Similarly, the strain gauge from the beam should be connected to a Wheatstone bridge circuit where the input and output of the circuit are connected to MSP432 DAQ. This configuration will make it easier to implement the damping treatment in the third experiment.

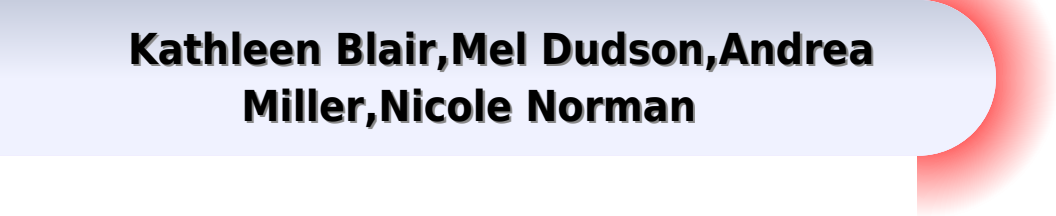
In this vibration lab, all strain gauge measurements should be made using the “High Speed DAQ” option at a sampling frequency of 2000 Hz and a buffer length of 15000 samples, which results in 7.5 seconds of test time.

5 Part 2: Static to Dynamic Measurements

In Lab 2, the strain gauge was shown to be accurate at estimating the static load and subsequent deflection of the free end of the cantilever beam. As a result, in this lab the strain gauge will be used to measure the beam tip displacement for the dynamic motion. It is important to note that the strain gauge can only be used

Vibration Lab Manual

**Kathleen Blair, Mel Dudson, Andrea
Miller, Nicole Norman**



Vibration Lab Manual:

Laboratory Manual: Instrumentation and Control Systems Lab V. Amarnath Reddy, **Lab Manual Latest Edition** Dr. J. P. Goel, 2016-12-17 Lab E Manual Physics For XIIth Practicals A Every student will perform 10 experiments 5 from each section 8 activities 4 from each section during the academic year Two demonstration experiments must be performed by the teacher with participation of students The students will maintain a record of these demonstration experiments B Evaluation Scheme for Practical Examination One experiment from any one section 8 Marks Two activities one from each section 4 4 8 Marks Practical record experiments activities 6 Marks Record of demonstration experiments Viva based on these experiments 3 Marks Viva on experiments activities 5 Marks Total 30 Marks Section A Experiments 1 To determine resistance per cm of a given wire by plotting a graph of potential difference versus current 2 To find resistance of a given wire using metre bridge and hence determine the specific resistance of its material 3 To verify the laws of combination series parallel of resistances using a metre bridge 4 To compare the emf of two given primary cells using potentiometer 5 To determine the internal resistance of given primary cells using potentiometer 6 To determine resistance of a galvanometer by half deflection method and to find its figure of merit 7 To convert the given galvanometer of known resistance and figure of merit into an ammeter and voltmeter of desired range and to verify the same 8 To find the frequency of the a c mains with a sonometer Activities 1 To measure the resistance and impedance of an inductor with or without iron core 2 To measure resistance voltage AC DC current AC and check continuity of a given circuit using multimeter 3 To assemble a household circuit comprising three bulbs three on off switches a fuse and a power source 4 To assemble the components of a given electrical circuit 5 To study the variation in potential drop with length of a wire for a steady current 6 To draw the diagram of a given open circuit comprising at least a battery resistor rheostat key ammeter and voltmeter Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram Section B Experiments 1 To find the value of v for different values of u in case of a concave mirror and to find the focal length 2 To find the focal length of a convex lens by plotting graphs between u and v or between $1/u$ and $1/v$ 3 To find the focal length of a convex mirror using a convex lens 4 To find the focal length of a concave lens using a convex lens 5 To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation 6 To determine refractive index of a glass slab using a travelling microscope 7 To find refractive index of a liquid by using i concave mirror ii convex lens and plane mirror 8 To draw the I V characteristic curve of a p n junction in forward bias and reverse bias 9 To draw the characteristic curve of a zener diode and to determine its reverse break down voltage 10 To study the characteristics of a common emitter npn or pnp transistor and to find out the values of current and voltage gains Activitie 1 To study effect of intensity of light by varying distance of the source on a L D R 2 To identify a diode a LED a transistor and IC a resistor and a capacitor from mixed collection of such items 3 Use of multimeter to i identify base of transistor ii

distinguish between npn and pnp type transistors iii see the unidirectional flow of current in case of a diode and a LED iv check whether a given electronic component e g diode transistor or I C is in working order 4 To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab 5 To observe polarization of liquid using two Polaroids 6 To observe diffraction of light due to a thin slit 7 To study the nature and size of the image formed by i convex lens ii concave mirror on a screen by using a candle and a screen for different distances of the candle from the lens mirror 8 To obtain a lens combination with the specified focal length by using two lenses from the given set of lenses Suggested Investigatory Projects 1 To investigate whether the energy of a simple pendulum is conserved 2 To determine the radius of gyration about the centre of mass of a metre scale as a bar pendulum 3 To investigate changes in the velocity of a body under the action of a constant force and determine its acceleration 4 To compare effectiveness of different materials as insulators of heat 5 To determine the wavelengths of laser beam by diffraction 6 To study various factors on which the internal resistance emf of a cell depends 7 To construct a time switch and study dependence of its time constant on various factors 8 To study infrared radiations emitted by different sources using photo transistor 9 To compare effectiveness of different materials as absorbers of sound 10 To design an automatic traffic signal system using suitable combination of logic gates 11 To study luminosity of various electric lamps of different powers and make 12 To compare the Young s modulus of elasticity of different specimens of rubber and also draw their elastic hysteresis curve 13 To study collision of two balls in two dimensions 14 To study frequency response of i a resistor an inductor and a capacitor ii RL circuit iii RC circuit iv LCR series circuit

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