ASEN 2803

DYNAMICS & CONTROLS LAB

SPRING 2025

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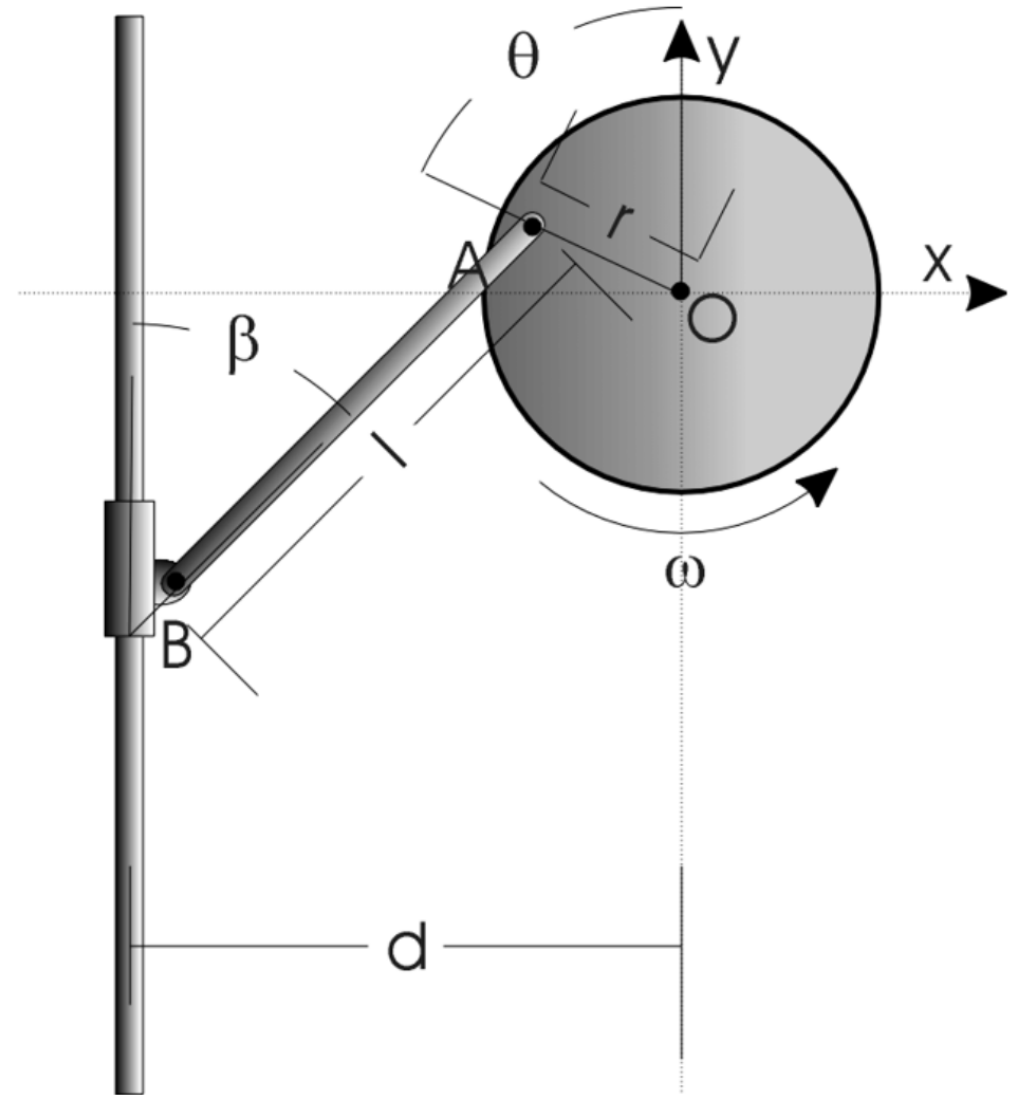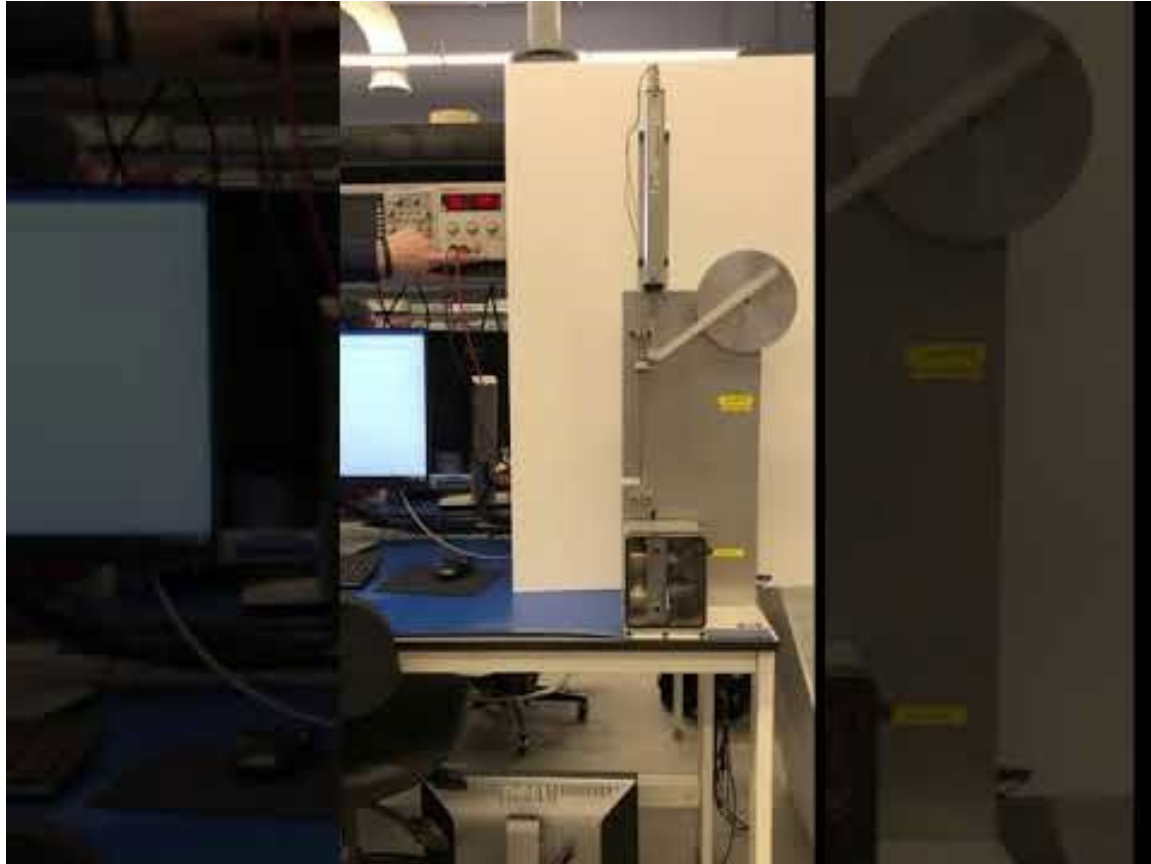

LAB 2 – LOCOMOTIVE CRANK

Problem Statement

The locomotive crank shaft apparatus is designed to demonstrate kinematic relationships for linked mechanisms. Students will develop a model for the ideal relationship between the rotational motion of the wheel and the translation of the collar. In this lab, we will use sensors to measure these motions and then compare the experimental results to the predictions.
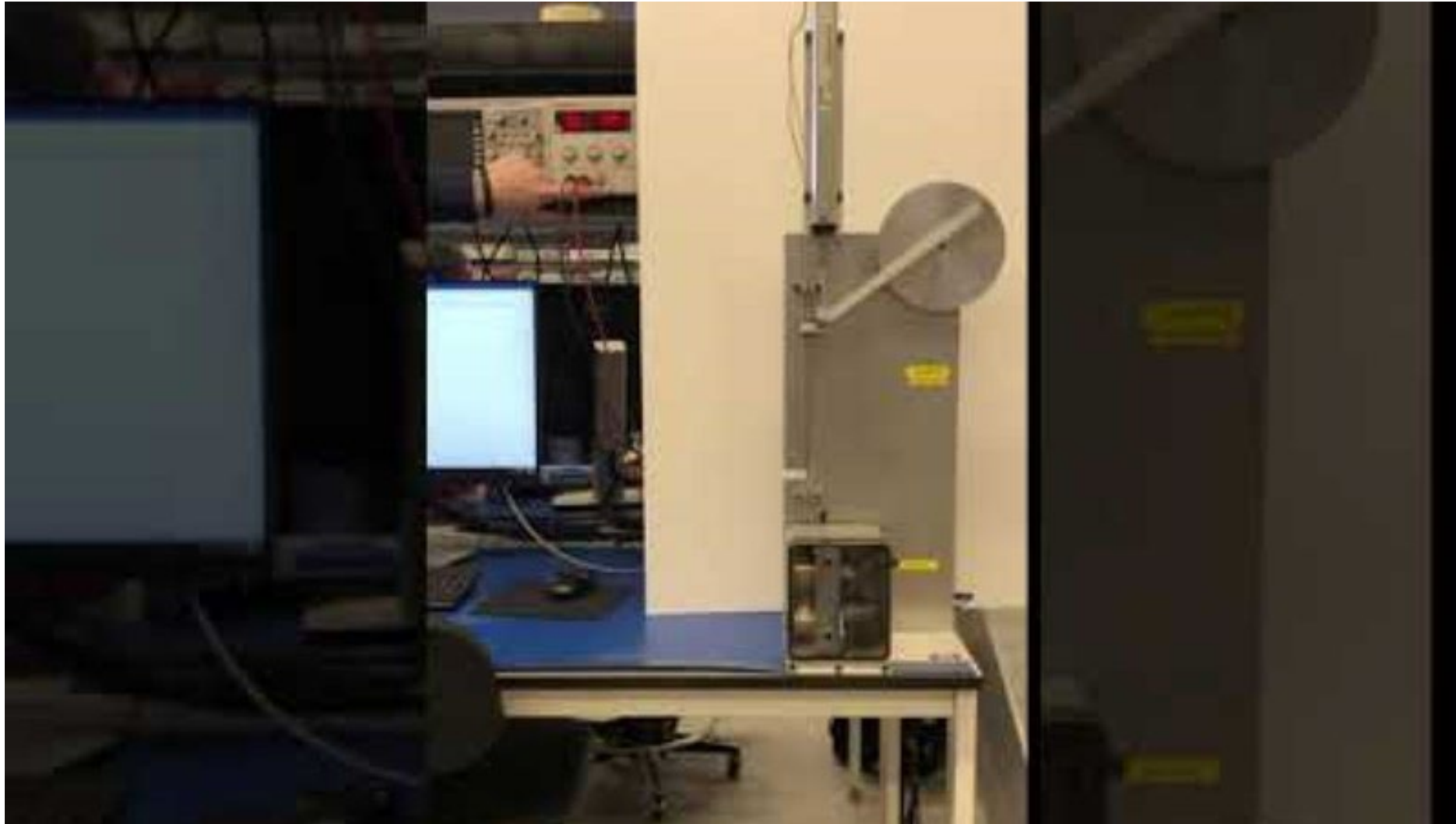
The primary objectives for this project are to:

1. **Analyze** general planar motion

2. **Practice** using kinematical descriptions of a physical system

3. **Investigate** discrepancies between a model and a physical system

4. **Assess** experimental results

5. Continue to **improve** MATLAB skills

Locomotive Crank

Video Demonstrations

Video Source: https://www.youtube.com/watch?v=hMJXxqgD2PY

Video Demonstrations

Video Source: https://www.youtube.com/watch?v=-RRj2XmhWqU

Outline of Tasks

- **First Steps: Assignment Familiarization**

  - Read the Lab 2 Assignment Document.

  - Read the Lab 2 Assignment Appendix.

  - Familiarize yourselves with the lab apparatus. Come up to the TF tables to view hardware.

  - Watch video demonstrations of the experiment at different voltages – video links are on the Canvas page.

  - Make physical measurements of hardware, propagate uncertainty. Look carefully at diagram and definition of parameters.

- **Complete all required tasks on the Lab 2 Assignment Document**

- **Package everything in a lab report**

Outline of Lab Report

- Reports should be written using the AIAA paper format. Word and LaTeX templates may be found at the following website: https://www.aiaa.org/publications/Meeting-Papers/Meeting-Paper-Author.

- Report is intended to be a "brief" assessment
    - Abstract
    - Model
    - Procedure and Experimental Setup
    - Results and Analysis
    - Conclusions and Recommendations
    - Member Contributions and Acknowledgements
    - Appendix: MATLAB Code

- See Lab 2 Assignment Document for full instructions.

Outline of Lab Report

- **Abstract**

  - Make sure to cover the Motivation, Problem Statement, Approach, Results, Conclusion.

  - *Extra Credit:* Highlight using different colors which part of your abstract is addressing each of the five areas above. Clearly indicate which color represents which area.

- **Derive Model**

  - Complete Steps 1-4.

  - The Lab 2 Assignment Document will help you through this.

  - Explain derivation step by step – walk the reader through the entire process. Examples:

    - "Taking the cross product of __ and __ in equation __ yields equation __".

    - "Assuming the i component of equation __ is zero, equation __ gives the relationship for velocity in the j direction as shown in figure ___"

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Outline of Lab Report

- **Procedure and Experimental Setup**

  - Complete Steps 5-7.

  - The Lab 2 Assignment Appendix will help you through this.

- **Results and Analysis**

  - Complete Steps 8-13.

  - Use provided data for analysis.

  - Include all required plots. Label your plots clearly. Explain your plots.

  - Also, look at the error vs. time (residuals) – Recall ASEN 2012 Least Squares

  - Observe any trends in the data that isn't apparent with `mean, std`

Outline of Lab Report

- **Conclusions and Recommendations**

  - Make sure to cover the *summary of work, what was learned from the work, comments on the experiment that performed best/worst*, and *recommendations to improve the model*.

  - *Extra Credit:* Highlight using different colors which part of your abstract is addressing each of the four areas above. Clearly indicate which color represents which area.

- **Member Contributions and Acknowledgements**

  - List the contributions of each team member (one to two sentences for each person).

  - Describe assistance or contributions provided by classmates or others (not including group members who authored the report).

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Outline of Lab Report

- **Appendix: MATLAB Code**

  - Include your full code

  - Make sure your code is reasonably well-commented and can be understood by someone else.

- See Lab 2 Assignment Document for full instructions.

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Acknowledgements

The contributions of the following faculty to the design of this lab assignment, associated material, and lab theory slides are acknowledged:

- Prof Penina Axelrad

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- Prof Bobby Hodgkinson