Engineering Mechanics: Dynamics

Project Description

1 Introduction

In the course, we spend a large part of our time learning how to analyze systems, both engineered and natural, with the principles of dynamics. It is equally important to learn to use the same principles to create or improve mechanical designs. This creative activity is at the heart of engineering. Therefore, you will do a project in which you use all the principles of engineering — and especially dynamics — you've encountered to analyze and improve an existing design, or invent a mechanical contraption.
You can work alone on this project, or in a team of up to four people. The project consists of three main parts.

- Find or create a design of a mechanical system that addresses a problem you are interested in solving and is relevant to you.
- Analyze the design and predict its performance.
- Make suggestions for changes to improve the design, and predict their effectiveness.

You might also build and test a model of the device, but that is not required. Your analyses will draw from dynamics topics — including rigid body dynamics, particle motion, and analyses of energy and momentum. The aim of the project is to give you practice in selecting a problem, identifying the key aspects of a proposed solution, analyzing that solution, and making suggestions for improvement. I don't intend the project to be especially complex or daunting. If you think you are getting mired down, see me and I will help you.

2 Topic ideas

These ideas are suggestions to get you started. You may decide to work on something entirely different, or modify the following examples. For instance, you might want to consider a small vehicle, but power it with a falling weight rather than a mousetrap. I urge you to consider problems relevant to your own life—perhaps those that arise in your workplace, hobbies, laboratory, or home—although analyses that spring forth wholly from curiosity or ideas for inventions can make great projects too.

Mousetrap vehicles

Some of you may have built mousetrap vehicles in previous engineering classes or in high school. A mousetrap vehicle is a small cart or car that is powered by a mousetrap. The vehicle might be designed to maximize the distance the mousetrap can travel, to travel a certain distance and then stop, or attain a high speed.

Trebuchets and catapults

A trebuchet is a medieval war machine that launches heavy projectiles large distances. See, for instance,

- ⟨`http://en.wikipedia.org/wiki/Trebuchet`⟩,
- ⟨`http://en.wikipedia.org/wiki/Catapult`⟩, and
- ⟨`http://www.punkinchunkin.com`⟩

for more information on trebuchets and catapults (and the produce that hates them).

Bicycles and automobiles

Vehicles, human–powered and otherwise, encompass many possible projects from the analysis of drive trains to efficiencies to the effects of collisions. For some information on human–powered vehicles, see

- ⟨`http://www.ihpva.org/hpva`⟩ and
- ⟨`http://www.asme.org/hpv`⟩.

Engineers Without Borders (EWB)

Engineers tend to seek out cutting edge technologies — and rightfully so, usually. Sometimes though, greater benefit may come from improving old, even ancient, technology. These latter situations are especially prevalent when the infrastructure or money needed for many advanced technologies is not present. Thus you might choose to analyze and improve upon water pumps, small power generators, farm equipment, and the like. See

- ⟨`http://www.ewb-usa.org`⟩,
- ⟨`http://www.clubs.psu.edu/up/esw`⟩,
- ⟨`http://www.itdg.org`⟩, and
- ⟨`http://www.sustainablevillage.com`⟩

for more information and ideas. You could send a sufficiently polished finished project to Engineers Without Borders, and possibly make a tangible difference in someone's life.

3 Proposals

Write a brief description of the problem you'd like to consider, and sketch out the design you will analyze. I strongly encourage you to meet with me to discuss your thoughts. Submit this proposal, along with a list of your team members (if applicable) to me by Friday 21 July. I will meet with each individual or team to make a list of specific deliverables.

4 Report

Prepare a report that describes your project. Be sure to include

- an explanation of your reasons for selecting the mechanical system you chose and why it is important to you and in general,
- a description of the machine or system you have analyzed,
- an explanation of your approach to its analysis,
- a list of assumptions you used in each calculation, and your justification for each,
- a mathematical analysis of the machine,
- ideas for improvement of the analyzed design,
- written arguments to support your ideas, and
- a mathematical analysis of the improvements to predict their effectiveness and quantitatively compare them,
- references for information sources and acknowledgments of help or ideas.

The report does not have to be typed, but it should be neat and have a logical flow. For instance, you could have typed descriptions, explanations, and arguments supplemented with handwritten, but well organized, mathematical analyses and diagrams.
Submit two copies of a rough draft of your report to me by Friday 5 August. I will read and offer feedback and suggestions on your draft. Your classmates will also provide feedback on your work, which you may then revise before submitting the final draft by Wednesday 10 August. If you worked in a team, please also provide a statement describing which team members performed each analysis and wrote it up. Have each team member sign the statement.

5 Parting advice

Pick a problem that interests you. Work hard, don't hesitate to ask questions, and have fun.