E91: Dynamics

www.swarthmore.edu/NatSci/mhsieh1/Courses/E91/

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With help from Prof. Vijay Kumar
What is Dynamics? The Big Picture

Three Parts

- **Geometry**
  - Shapes, curves

- **Kinematics**
  - Motion
  - Curves, shapes + time

- **Kinetics**
  - Motion and the causes of motion (forces)

Types of Problems

- Describe motion
- Given a motion, what are forces that caused it?
- Given a set of forces, can we predict the motion resulting from them?
Why Should We Study Dynamics?

Motivating Examples

- Cruise missile
- Animation
- Mechanisms

auto.howstuffworks.com/engine.htm
Mechanism: The Electric Screwdriver

http://www.howstuffworks.com/inside-sd.htm
http://auto.howstuffworks.com/gear-ratio4.htm
Haptics

E91: Dynamics

Remote Control PC

 Courtesy of Mark Cutkosky

Haptic Device

Courtesy of Dave Cappelleri

Manipulator

Manipulation Tools

Inverted Optical Microscope

CCD Camera

Courtesy of Intuitive Surgical
Head-controlled Feeding Device for Quadriplegics

- Head motion controls a passive (mechanical) feeder
Big, Small, and Little Dogs

Courtesy of Boston Dynamics

http://www.youtube.com/watch?v=mpBG-nSRcrQ

Courtesy of Sony
Dynamics: A Historical Perspective

Chapter I:

- Newtonian Mechanics
  - Kepler’s Planetary motion
  - Galileo – importance of acceleration
  - Newton – *Principia Mathematica* (1687)

100 Years Later …
Chapter II

- Lagrangian Mechanics
  - Bernoulli – principle of virtual work, statics
  - Euler – dynamics of rotating rigid bodies
  - D’Alembert – extension of virtual work to dynamics
  - Lagrange – *Mechanique Analytique* (1788)

Analytical Mechanics

- Analytical because it is based on few fundamental principles
- Lagrange describes it as an approach which does not require drawing any diagrams (e.g. free body diagrams)
Focus of E91

- Newtonian Mechanics with introduction to Analytical Mechanics
- No relativistic effects (no quantum mechanics)
  - Reasonable velocities
  - Reasonable length scales
- Practical Problems
- Analysis and Design
Agenda

- Introduction
- Where to get information
  - Course website
  - Google, etc.
- Syllabus
- Course Policies
  - Text(s)
  - Homework
  - Labs
  - Machine Shop
  - Internet
- Survey
- Determining a Lab Time
- Possibility of rescheduling course (?)