Course Description

In this online summer course students learn how to critically evaluate Hollywood action movies using the laws of physics and Fermi type estimation techniques. After being given the background physics and quantitative training required to understand a particular topic, students will typically be shown a movie clip and asked to quantitatively judge the veracity of the physics in the scene. Is it a good or bad representation of what actually happens in the real world? Assignments will involve both solving physics word problems and evaluating movie clips such as an action scene or a ‘doomsday scenario’ (e.g. abrupt onset of an ice age triggered by changes in the ocean currents).

For example: Which requires the most force? Stopping a runaway subway train or catapulting a large farm animal onto a bunch of English knights?

By the end of the semester, the student who takes this course will be able make quick back of the envelope estimates to determine whether a particular 'movie action scene' is feasible or not. Emphasis will be on problem solving on the fly, in class and/or while watching a movie.

If you claim a scene violates the laws of physics, you need to be able to back up that claim with a sound quantitative argument. This is what students learn to do in Movie Physics.
Instructor and Teaching Fellow

Instructor: Frank Robinson
• Office Hours: Schedule via email
• Email: frank.robinson@yale.edu

Teaching Fellow: Vladimir Sivak
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General Course Information

Online Virtual Classroom Meeting: Monday, Wednesday 10:00am-11:30pm (EST)

Students are required to participate in two online section meetings per week in our “virtual classroom”. During these virtual classroom sections, students will participate in open discussions with Professor Robinson. It is expected that you will have already watched the lectures before each online classroom meeting begins.

Lectures: You will be required to watch 80 online lecture videos (most are 5-15 minutes long) on your own. You are expected to watch the lectures needed for each online discussion before the online meeting time. Note that some weeks, you will be expected to watch 3 hours of lecture videos, so do plan your schedule so that you can keep up with lecture viewing. Much of the information on the exams will come directly from what is presented in the lectures.

Recommended reading: Quantum Mechanics: John Gribbin; "In Search of Schrodinger's cat"
Grading Breakdown

Your final grade in the course will be based on:
• 30% Final Exam (written test, followed by oral test)
• 30% Midterm Exam (written test, followed by oral test)
• 15% Homework
• 25% Participation in online section discussion (including clicker review questions)

Final Exam: Scheduled to be taken Friday, June 29. The final exam is cumulative and will cover all material discussed in the lectures and readings. You must take the final exam during this timeslot. After finishing the exam, students will have a 5-10 minute one on one oral test with the instructor (typically they will be asked to explain one of their answers in the exam).

Midterm Exam: Scheduled to be taken during the online class meeting on Monday June 11. The midterm will cover readings and lectures up to and including Wednesday June 6. You must be available to take the midterm during this time slot. After finishing the exam, students will have a 5-10 minute one on one oral test with the instructor (typically they will be asked to explain one of their answers in the exam).

Online Discussion Section Participation: You will also receive a grade based on your online section participation. The goal of these discussions is to develop good problem solving skills required to solve homework problems, answer exam questions and understand lecture material.

During the course, students will receive homework problems twice a week. Typically one homework will be assigned on Tuesday (due the following Thursday) and one will be assigned Friday (due the following Monday). I will provide hints on how to do these type of problems during section, but it’s ideal if you try do these problems on your own (or in groups) before class.

Academic Honesty: Both the midterm and the final exam are closed book, which means the use of any written material or any form of collaboration is forbidden. For a short but useful discussion, see: http://yalecollege.yale.edu/content/cheating-plagiarism-and-documentation. All suspected cases of cheating will make be reported to the Yale College Executive Committee.
Dates, Topics, and Readings

Class 1: Math review. How to make a good guess. Extracting useful data from a movie clip. (Chapter 1)

Monday, May 28: Open Questions & Discussion of Chapter 1

Introduction and orientation, class overview
Accuracy, sig figs,
The geometric mean, guesstimation sample problems.

Class 2: Kinematics (Chapter 2)

Wednesday, May 30: Discussion of Problem Set #1 and Chapter 2

Scalars and vectors, velocity and acceleration
Getting kinematic data from clips
Equations of motion in a straight line, applications to uniform acceleration.

Class 3: Two dimensional motion. Newton’s laws of motion. The physics of jumping (Chapters 3, 4 & 5).

Monday, June 4: Open Questions & Discussion of Problem Set #2 & Chapters 3, 4 & 5

Projectile motion
Newton’s laws of motion
The physics of jumping
Jump contact time/distance. Movie example.

Class 4: Damping forces. Air resistance (drag). Friction (Chapters 6 & 7)

Wednesday, June 6: Discussion of Problem Set #3 & Chapters 6 & 7

Air resistance. Terminal velocity
Indiana Jones falling to the ground in a dingy
How to drive a car on the ceiling (lift).
Friction and 007.
Class 5: Midterm (Chapters 1-7)
Monday, June 11: Midterm Exam (written and oral tests)

Class 6: Circular motion (Chapter 8)
Wednesday, June 13: Discussion of Problem Set #4 & Chapter 8

Introduction to circular motion.
Example “Tray and cup demo”.
Artificial gravity

Class 7: Gravitation and Energy (Chapters 9 & 10)
Monday, June 18: General Q&A. Discussion of Problem Set #5 & Chapters 9 & 10

Weightlessness
Orbits
Newton’s law of gravitation
Estimating g and other quantities on the asteroid in Armageddon
What is energy?
Forms of energy.
Work and energy
Disorder and the arrow of time.

Class 8: Waves (Chapter 12)
Wednesday, June 20: Discussion of Problem Set #6 and Chapter 12

Intro. to waves.
Properties of waves.
Combining waves.
Sound.
Electromagnetic spectrum.

Class 9: Quantum Mechanics & Anthropogenic Climate Change (Chapters 13 &14)
Monday, June 25: Discussion of Problem Set #7 & Chapters 13 &14

Waves and particles
The photoelectric effect.
Double slit experiment (Dr Quantum video).
Heisenberg’s uncertainty principle
Radiation and steady state.
Global energy budget
Radiative forcing
Climate sensitivity
Forcings and feedbacks

Class 10: Review

Wednesday, June 27: Exam review session

Final Exam: Friday June 29 (Chapters 1-14)

(exam excludes material in Chapter 11)

Friday, June 29: Final Exam (written and oral tes