PHYS101E
“Movie Physics”
Summer 2018

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: TBA
• Office Hours: Schedule via email
• Email: tba

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 40 online lecture videos (each about 20 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)

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 Friday June 8. 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).

Final Exam: Scheduled to be taken during the online class meeting on 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).

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 the 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://catalog.yale.edu/undergraduate-regulations/policies/definitions-plagiarism-cheating/.** All suspected cases of cheating will 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

Monday, May 28: Open Questions & Discussion of Lectures 1-3

Online Lecture 1: Introduction and orientation, class overview
Online Lecture 2: Accuracy, sig figs,
Online Lecture 3: the geometric mean, guesstimation sample problems.

Class 2: Kinematics

Wednesday, May 30: Discussion of Problem Set #1 and Lectures 4-7

Online Lecture 4: Scalars and vectors, velocity and acceleration
Online Lecture 5: Getting kinematic data from clips
Online Lecture 6: Equations of motion in a straight line, applications to uniform acceleration.
Online Lecture 7: worked out problems.

Class 3: Two-dimensional motion, Newton's laws of motion

Friday, June 1: Discussion of Problem Set #2 and Lectures 8-9

Online Lecture 8: Projectile motion
Online Lecture 9: Newton's laws of motion

Class 4: The physics of jumping

Monday, June 4: Open Questions & Discussion of Lectures 10-11

Online Lecture 10: The physics of jumping
Online Lecture 11: Jump contact time/distance. Movie example.

Class 5: Damping forces. Air resistance (drag), Friction

Wednesday, June 6: Discussion of Problem Set #3 and Lectures 12-15

Online Lecture 12: Air resistance. Terminal velocity
Online Lecture 13: Indiana Jones falling to the ground in a dingy
Online Lecture 14: How to drive a car on the ceiling (lift).
Online Lecture 15: Friction and 007.

Class 6: Review (Clicker questions)

Friday, June 8: Midterm Review session with Frank Robinson

Class 7: Midterm (classes 1-7)

Monday, June 11: Midterm Exam (written and oral tests)

Class 8: Circular motion

Wednesday, June 13: Discussion of Problem Set #4 and Lectures 16-18

Online Lecture 16: Introduction to circular motion.
Online Lecture 17: Example "Tray and cup demo".
Online Lecture 18: Artificial gravity

Class 9: Life in the International space station, Gravitation

Friday, June 15: Discussion of Problem Set #5 and Lectures 19-22

Online Lecture 19: Weightlessness
Online Lecture 20: Orbits
Online Lecture 21: Newton's law of gravitation
Online Lecture 22: Estimating g and other quantities on the asteroid in Armageddon

Class 10: Energy

Monday, June 18: General Q&A. Discussion of Lectures 22-25

Online Lecture 22: What is energy?
Online Lecture 23: Forms of energy.
Online Lecture 24: Work and energy
Online Lecture 25: Disorder and the arrow of time.

Class 11: Waves

Wednesday, June 20: Discussion of Problem Set #6 and Lectures 26-30

Online Lecture 26: Intro. to waves.
Online Lecture 27: Properties of waves.
Online Lecture 28: Combining waves.
Online Lecture 29: Sound.
Online Lecture 30: Electromagnetic spectrum.

Class 12: Quantum mechanics and the movies

Friday, June 22: Discussion of Problem Set #7 and Lectures 31-35

Online Lecture 31: Waves and particles
Online Lecture 32: The photoelectric effect.
Online Lecture 33: Double slit experiment (Dr Quantum video).
Online Lecture 34: Heisenberg's uncertainty principle
Online Lecture 35: QM in the movies

Class 13: Anthropogenic climate change

Monday, June 25: Discussion of Global Warming & Lectures 36-40

Online Lecture 36: Radiation and steady state.
Online Lecture 37: Global energy budget
Online Lecture 38: Radiative forcing
Online Lecture 39: Climate sensitivity
Online Lecture 40: Forcings and feedbacks

Class 14: Review (Clicker questions)

Wednesday, June 27: Exam review session

Class 15: Final Exam (classes 1-14)

Friday, June 29: Final Exam (written and oral test)