

PHYS101E

Movie Physics

Summer Session A

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](#)

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Teaching Fellow: [Iver Warburton](#)

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General Course Information

Online Virtual Classroom Meeting: Monday & Wednesday 10:00am-11:30am (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 and the TF. It is expected that you will have already watched and made your own notes from the lectures before each online classroom meeting begins.

Lectures: Before each "Virtual Classroom Meeting" you will be required to watch a set of online lecture videos (each 5-20 minutes long) on your own. You are expected to **watch and take notes** from the lectures needed for each online discussion before the online meeting time. Note that some weeks, you will be expected to watch 2 hours of lecture videos before a meeting, 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. *It is your responsibility to put together a set of detailed notes based on the lectures.*

Grading Breakdown

Your final grade in the course will be based on:

- 30% Final Exam composed of a written test (20%) and an oral test (10%)
- 30% Midterm Exam composed of a written test (20%) and an oral test (10%)
- 15% Homework assignments (5 problem sets)
- 25% Participation in online section discussion (15%) and lecture mini-quiz participation (10%)

Final Exam: Scheduled to be taken at 10 am on Wednesday June 25th. 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 (we will not be using Examity). After finishing the exam, students will have a 5-10 minute one on one oral test with one of the instructors (typically they will be asked to either one of their answers in the exam or describe how they would solve a similar problem).

Midterm Exam: Scheduled to be taken during the online class meeting at 10am on Monday June 9th. The midterm will cover readings and lectures up to and including class before midterm (we will not be using Examity). 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 one of the instructors (typically they will be asked to explain one of their answers in the exam or describe how they would solve a similar problem.)

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.

Attendance: Class will meet on Zoom twice a week to discuss the material and work through example problems. Attendance is mandatory.

Homework: During the course students will receive homework problems once a week. Typically, a homework will be assigned on Monday and due the following Friday at 12 pm EST (noon). We will provide hints on how to do these types of problems during discussion section, but it's ideal if you try do these problems on your own (or in groups) before class. Late HomeWorks will be given a maximum of 50 % for one day late and 25 % for 2 days late. You will scan your written homework and upload it to Canvas. You will be responsible for the legibility of your work, which includes handwriting *and* scanning. You may also typeset your homework (using LaTeX, etc.), in which case you are only responsible for typos.

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/faculty-staff/faculty/handbook-instructors-undergraduates-yale-college/teaching/academic-dishonesty>. All suspected cases of cheating will be reported to the Yale College Executive Committee.

AI Statement: Before collaborating with an AI chatbot on your work for this course, please request permission by sending me a note that describes (a) how you intend to use the tool and (b) how using it will enhance your learning. Any use of AI to complete an assignment must be acknowledged in a citation that includes the prompt you submitted to the bot, the date of access, and the URL of the program.

Dates, Topics, and Lectures

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

Monday May 26: Open questions & discussion.

Introduction and orientation, class overview

Accuracy, sig figs

The geometric mean, guesstimation sample problems.

Class 2: Kinematics (Chapter 2)

Wednesday May 28: Discussion of Problem Set #1

Scalars and vectors, velocity and acceleration

Getting kinematic data from clips

Equations of motion in a straight line, applications to uniform acceleration.

Class 3: Vectors and two-dimensional motion (Chapter 3)

Monday June 2: Open questions & discussion

Overview on vectors

Projectile motion

Applications to movies.

Class 4: Newton's laws of motion. The physics of jumping (Chapters 4 &5)

Wednesday June 4: Open questions & discussion of problem set 2.

Newton's laws of motion – applications of $F=ma$ to movies

The physics of jumping

Jump contact time/distance. Movie examples.

Class 5: Midterm (Chapters 1-5)

Monday June 9: Midterm Exam (written and oral tests)

Class 6: Damping forces: Air resistance (drag), friction and lift (Chapters 6 & 7)

Wednesday June 11: Discussion of problem set 3.

Air resistance. Terminal velocity

Indiana Jones falling to the ground in a dingy

Friction and 007.

How to drive a car on the ceiling (lift).

Class 7: Uniform circular motion (Chapter 8)

Monday June 16: Open questions & discussion

Introduction to circular motion. "Tray and cup demo". Artificial gravity, weightlessness, orbits.

Class 8: Energy and Momentum (Chapter 9)

Wednesday June 18: Open questions & discussion of problem set 4

What is energy? Forms of energy. Work and energy

Disorder and the arrow of time.

Violations of energy/momentum conservation in movies.

Class 9: Rotation (Chapter 10).

Monday June 23: Open questions & discussion of problem set 5.

Torque, rotational inertia, rotational kinematics & dynamics.

Newton's Laws for rotation.

Angular momentum conservation.

Applications to spinning objects in movies, e.g. the 'famous' 007 corkscrew car jump

Class 10: Final Exam: (Chapters 1-10)

Wednesday June 25: Final Exam

Note: Homework 5 due on last Friday of summer session 1.