PHYS-3202 Class Project Instructions

You will carry out a project involving both analytical and numerical calculations and write up your results in an article style. This project will address classical mechanics in popular culture. You should find a scene or event in a film, book, etc, that you can analyze using some topic from this course (air resistance, use of differential equations, orbits, accelerating reference frames, rotating objects, etc). It does not need to be English-language media. An example could be the scene in *The Martian* where the astronaut jumps from a rocket to be rescued. You could analyze his trajectory in orbit, the effect of air resistance from the air escaping from his rocket, etc. Most importantly, you should answer whether the scene or event could really happen as portrayed.

At a minimum, I expect that these projects should require time and effort equivalent to approximately two weeks worth of homework assignments, and the written report should be at least 5 pages (including title information, abstract, and bibliography). You are, of course, free to spend as much time and effort as you like, as well as to write a longer paper. Your project must have both an analytical/theoretical and a numerical component. You may use any software you are comfortable with (for example, Maple, python, C++, etc) for the numerical work. You must include your code as an appendix to the paper.

You may work in groups, as discussed below. You must have me approve the topic of your project by **17 Nov 2020**; we may need to discuss your plans in a zoom meeting. The reports are due at **10:59PM on 10 Dec 2020** by upload to the homework submission link `https://uwcloud.uwinnipeg.ca/s/LLijRqSDKdXgMDA`. **This project is worth 15% of your final course grade.**

Please send me an email if you have any questions. If you need access, the UWinnipeg library has ebooks as well as streaming of many movies. If you want to analyze a problem that's not related to the depiction of classical mechanics in popular culture, please contact me.

Group Work

You are allowed and encouraged to work in groups of up to three students. In this case, the total effort (not necessarily the total length of the report) should increase accordingly; that is, the project from a group of three students should represent three times as much effort as an individual student's project. Furthermore, in addition to a single written report from the group, I will require a statement from each student in the group regarding the contributions of each group member to the project. In other words, students A, B, and C working in a group should each submit a statement indicating that student A did $X\%$ of the work on calculation Y and wrote all of the corresponding section of the paper, etc.

Report Format and Outline

One goal of this project is to give you experience in writing a physics article in the style expected for a research journal since writing technical reports is a requirement of many jobs, not just in academia (though the topic will be somewhat less formal, of course).

The article itself should be written using either the LaTeX or MS Word template available on the course web page. (LaTeX format is strongly preferred.) In either case, the report should be delivered as a single PDF file. If you opt to use the MS Word template, you **must** use an equation editor to display your math. You also **must** have a bibliography with references cited by number in the text. The bibliography should be ordered in the order references are cited (see the templates).

Your report should cover all the information described here. In the template, these are given as separate sections. You may use these sections or organize the article as seems logical to you, but it should be sectioned in some way.

- **Title Material**: The beginning of the article should give a title, a list of authors, and a short abstract giving a brief description of the project and summary of the results in a few sentences.

- **Introduction**: Describe the scene/event in popular culture that you are studying and the physics you need to analyze it. Review and cite any references you have read about the problem *in your own words.* Indicate what the results will be.

- **Methods**: Describe the equations that you will need to solve and the methods you will use to solve them. These should involve both your analytical approach or approximation methods (such as approximating a potential near its minimum as a harmonic oscillator) and how you set up the problem for solution on a computer. It is likely that most of your typeset formulae will appear in this section.

- **Results**: Present both your analytic and numeric/computational results. This will include formulae for analytic solutions and some representation of numerical solutions. Plots are recommended.

- **Discussion**: Discuss the conclusions of your project in the context of the scene/event. Could the scene have happened as written or shown?

Evaluation
Marks for the class project will be based on the following distribution:

- **Topic/Plans**: 10%
  You must have your topic approved by **17 Nov 2020**. This includes identifying any group working together. You will automatically receive these marks if your topic is approved on time.

- **Effort**: 20%
  Does the project show evidence of sufficient effort (ie, equivalent to 2 homework assignments per student in the group)?

- **Format**: 10%
  Are the title material and abstract laid out correctly? Is the format of the article including bibliography correct? Is it logically laid out? Is mathematics properly formatted in LaTeX or an equation editor?

- **Description of Scene**: 10%
  Do you clearly describe the scene or event and the physics necessary to understand it? Do you refer to it in some concluding section in the context of your results?

- **Discussion of Methods**: 20%
  Is there sufficient mathematical analysis to solve the problem? Is it explained clearly? Are the techniques you use, including computational ones, understandable?

- **Discussion of Results**: 20%
  Are results explained thoroughly? If plots are appropriate, are they labeled completely, captioned, and described in the main text? Have you considered enough angles of the problem? Do you have both analytical and computational results?

- **Computational Code**: 10%
  Is your code for the numerical work attached as an appendix? Is it clear how the code relates to the methods discussed in the main body of the paper?

Typically, if the work is divided reasonably equitably, all students in a group will receive the same marks. However, if student responses indicate that the workload was distributed in a highly uneven manner, I reserve the right to adjust grades as appropriate.

Suggested Topics
There are many events shown in popular culture that illustrate a physics concept. Here are a few examples drawn from Hollywood (note that you can choose media from other countries or languages):

- *Speed* (1994) about a bus that has to keep driving above 50 miles per hour. In one scene, it jumps over a gap in a bridge — could it do that with realistic air resistance?

- *The Martian* (2015) about an astronaut stranded on Mars. One scene is as described at the top of the instructions.

- *Gravity* (2013) about astronauts floating above earth without spacecraft. Are any of the orbits realistic? Are maneuvers with makeshift thrusters realistic?

- *Passengers* (2016) about an interstellar spaceflight. There is a gravitational assist (to boost speed relative to the galaxy), as well as artificial gravity due to rotation of the spacecraft. Are these portrayed realistically?

The UWinnipeg library has the first three above available to stream. Of course, these are just a few possibilities. Remember that I must approve your topic choice at an in-person meeting by **Nov 17**.