

# IPS\*1500 Interdisciplinary Mathematics and Physics

## Department of Mathematics and Statistics; Department of Physics

### Course Outline

Fall 2020 Course			
	Name	Office	e-mail
Professors:	Daniel Kraus (math.)	MacNaughton 511	dkraus@uoguelph.ca
	Dennis Muecher (phys.)	MacNaughton 224	dmuecher@uoguelph.ca
Teaching Assistants:	Amanda Saunders (math.)		asaunder@uoguelph.ca
	Eamonn Corrigan (phys.)		eamonn@uoguelph.ca
	Drake Lee (phys.)		dlee14@uoguelph.ca
	Matthew Steffler (phys.)		stefflerm@uoguelph.ca
	Bryn Knight (phys.)		knightb@uoguelph.ca

### Disclaimers:

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website <https://news.uoguelph.ca/2019-novel-coronavirus-information/> and circulated by email.

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.

By enrolling in a course, unless explicitly stated and brought forward to their instructor, it is assumed that students agree to the possibility of being recorded during lecture, seminar or other "live" course activities, whether delivery is in-class or online/remote. If a student prefers not to be distinguishable during a recording, they may:

- turn off their camera
- edit their name (e.g., initials only) upon entry to each session
- mute their microphone
- use the chat function to pose questions.

Students who express to their instructor that they, or a reference to their name or person, do not wish to be recorded may discuss possible alternatives or accommodations with their instructor.

Inappropriate online behaviour will not be tolerated. Examples of inappropriate online behaviour include:

- Posting inflammatory messages about your instructor or fellow students
- Stating false claims about lost quiz answers or other assignment submissions
- Using obscene or offensive language online
- Threatening or harassing a student or instructor online
- Copying or presenting someone else's work as your own
- Discriminating against fellow students, instructors and/or TAs
- Adapting information from the Internet without using proper citations or references
- Using the course website to promote profit-driven products or services
- Buying or selling term papers or assignments
- Attempting to compromise the security or functionality of the learning management system
- Posting or selling course materials to course notes websites
- Sharing your user name and password
- Having someone else complete your quiz or completing a quiz for/with another student
- Recording lectures without the permission of the instructor

## Course Description:

This is a foundational course for students in B.Sc. mathematical and physical sciences majors. The disciplines of Mathematics and Physics are taught in an integrated fashion that demonstrates how they support and enrich one another. Measurement and uncertainty, algebra and trigonometry, forces and Newton's laws, functions and graphing, differentiation, angular momentum and energy conservation, limits, integration, kinematics, simple harmonic motion, and special relativity are presented in a harmonized fashion to ensure students have an improved understanding of these fundamentals.

**Prerequisites:** 4U Calculus and Vectors or equivalent, 4U Physics or PHYS\*1020 or equivalent.

**Restrictions:** MATH\*1200, PHYS\*1000. Restricted to B.Sc. students in APMS:C, BPCH, BPCH:C, BMPH, BMPH:C, CHPY, CHPY:C, CHEM, CHEM:C, MATH, NANO, NANO:C, PSCI, PHYS, PHYS:C, STAT, THPY

**Course Objectives:** The course is intended to give a student a grounding in topics in physics and calculus in a manner that uses the physics as an example to ground the calculus and provides the calculus needed for the topics in physics. This integration of the two courses is intended to make both sets of material easier to absorb. Specific topics are listed subsequently under the heading *Course Topics*.

### Meeting Times

Lectures: **Math:** asynchronous (**YouTube links provided on Courselink**), **Physics:** Mo/Wed/Fr 1:30-2:20 in **Zoom (live)**

## Course Materials

**University Physics, 14th or 15th Edition, Volumes 1, 2, and 3**, by *H. Young and R. Freedman* (this will also be used in IPS\*1510 in Winter 2021). This book is available in the University Bookstore.

**Quick Start Calculus for Integrated Physics, Fourth Edition**, by *D. Ashlock* (this will also be used in IPS\*1510 in Winter 2021). This book is available in the University Bookstore and the Co-op Bookstore.

**Online Homework (FlipItPhysics (formerly smartPHYSICS))**. There will be assigned warm-up questions that will be graded online, i.e., on the web, using FlipIt Physics (see handout for more details). *Research has shown that this software has a positive effect on students learning of physics.* To complete the online homework, you will need to purchase a stand-alone Student Access Kit for FlipItPhysics. The University Bookstore offers one semester access cards (or two semester cards for students going on to IPS\*1510 in the Winter).

**i-Clicker/Reef Student Response Systems** (commonly known as *clickers*): You can purchase a license for compatible smartphones through the University Bookstore. The use of the iClicker reef system is not mandatory this year.

Physics Labs/Tutorials Times*		
Section	Time	Location
0101	Tues. 8:30-11:20	virtual (synchronous)
0102	Thur. 8:30-11:20	virtual (synchronous)
0103	Wed. 2:30-5:20	virtual (synchronous)
0104	Tues. 7:00-9:50	virtual (synchronous)
Mathematics Tutorial Times*		
0102, 0103, 0105	Tues. 11:30-12:20	virtual (synchronous)
0101, 0104	Fri. 12:30-1:20	virtual (synchronous)

\*Math & Physics quizzes are given during tutorials

**Course Website:** <https://courselink.uoguelph.ca>

**Credit Weight: 1.0** This weighting should be reflected in your efforts and apportioned study time.

## Library Reference Material

There are many additional reference texts available on the library shelves. Look for call numbers beginning with QC21 or QC23 (Physics), QA155, QA303 (Math).

## Course Themes

This course is divided into themes in order to emphasize some of the applications of physics and mathematics. The thematic approach is intended to give the material a grounding in the physical world outside of the classroom.

1. **Becoming a Scientist (Weeks 1-2)** This section will emphasize the scientific method, the importance of errors and error propagation in experiments, and introduce students to basic statistical quantities such as the mean and standard deviation. An inquiry-based laboratory exercise has been designed to allow students to explore the differences between random and systematic errors, and become familiar with calculating statistical quantities from experimental data.
2. **Sport (Weeks 2-6)** Physical activity is an important part of a healthy lifestyle; we will connect healthy living to physics and mathematics by showing examples of physics concepts such as kinematics, forces, circular motion, and torque in sports. A calculus-based approach will be used for solving problems.
3. **Natural Phenomena (Weeks 6-10)** An understanding and appreciation for the world and materials around us is the emphasis of this section. This section will discuss the enormous energy provided by the sun, fluid dynamics and the flow of water through rivers, compare man-made and natural materials such as steel and spider-silk, and look at nanomaterials which are used to explain certain phenomena such as how geckos can climb walls.
4. **Space travel (Weeks 11-12)** People have always been fascinated by space: the planets, stars, galaxies, etc. In this part of the course, we explore circular motion and forces in terms of objects orbiting about one another. We also introduce the concept of special relativity (specifically time dilation, and length contraction) which was proposed by Albert Einstein in 1905.

## Evaluation

Assessment	Weight
Math Quizzes (9)	10 %
Math Homework (9)	10 %
Physics Quizzes (3)	12 %
Online Homework (smartPHYSICS) (6-8)	5 %
Case Study	8 %
Laboratory Experiments (5)	15 %
Midterm	15 %
Final Exam	25 %
Total	100%

**Math Quizzes:** Mathematics tutorials will involve open-book group quizzes. You will work together in small groups on Zoom, and the quizzes will cover recent material.

**Math Homework:** Assigned weekly, due on Monday (unless Monday is a holiday, in which case the homework will be due on the following Wednesday). No late homework is accepted without appropriate justification. Work is to be submitted via Courselink Dropbox. Work can either be written and scanned or created digitally (writing on a tablet, using L<sup>A</sup>T<sub>E</sub>X, etc.).

**Physics Quizzes:** During three of the physics tutorial periods (see schedule), after receiving help for 90 minutes you will write a short quiz via Courselink. Details regarding what the quizzes will cover will be provided during the semester. These tutorials will be held online via Zoom.

**Online Homework:** During the course of the semester there will be 6-8 online homework (FlipItPhysics) assignments for students to complete.

**Case Study:** There will be a case study exercise which will be completed individually. These integrated activities involve the mathematically modelling a simple and gradually more complex depictions of physical situations.

**Laboratory Experiments:** The physics lab experiments (see schedule) are described in detail in the Lab handouts posted on CourseLink. This year, experiments will be conducted at home using "IOLab" devices. Details about renting/buying IOLab devices will be provided on Courselink. Reports have to be handed in using Jupyter Notebooks (Python).

**Midterm Examination:** The midterm exam will be held outside of class time in **week 6** (exact time TBA). The midterm will consist of both multiple choice questions and problems. More details will be provided by your professors as the exam time approaches.

**Final Examination:** The final examination will be held on Wednesday, Dec. 16 from 11:30am-1:30pm. The exam will be held online via Zoom. Details will be discussed during the semester. The exam will cover the entire course.

**Tutorial Periods:** The tutorial periods will be devoted to the development of problem-solving skills. All tutorials will be given online (synchronous).

## Course Topics, by Week

Week	Physics topics	Young and Freedman	Math topics	Quick-start
Sept. 11 and 14-18	The scientific method, measurement and error, error analysis	Ch 1.1-1.6 Laboratory Manual Taylor (Error Analysis)	Math you should know	Chapter 1
Sept. 21-25	Motion, 1-D kinematics	Ch 1.3, 1.7-1.10, 2	Derivatives and derivative rules	Chapter 2
Sept. 28-Oct. 2	1-D kinematics, 2-D kinematics, causes of motion - forces	Ch 2, 3, 4	Curve sketching and Optimization	Chapter 3
Oct. 5- Oct.9	Newton's laws, friction	Ch 3, 4, 5	Optimization and Integration	Chapter 4
Oct. 14-16	relative motion, midterm review	Ch 3, 4, 5	Optimization and Integration, midterm review	Chapter 4
Oct. 19-23	Circular motion, introduction to energy	Ch 3, 6	Vectors, parametric and polar curves	Chapter 5
Oct. 26-30	Conservation of energy, momentum, impulse and collisions	Ch 6, 7, 8	Polynomials, L'Hôpital's rule	Chapter 6
Nov. 02-Nov. 6	Rotational motion, Rotational energy, moment of inertia	Ch 9	Methods of Integration, Definite integrals	Chapter 7
Nov. 9-13	Torque, angular momentum, equilibrium and elasticity, fluid statics	Ch 10, 11, 12	Derivatives and continuity; mean value theorem	Chapter 8
Nov. 16-20	Fluid mechanics, materials/nanomaterials	Ch 12	Review to this point, differential equations	Chapter 9
Nov. 23-27	Kinematics revisited-simple harmonic motion, special relativity	Ch 14, 37	Differential equations	Chapter 9
Nov. 30-Dec. 4	Special relativity, exam review	Ch 37, all chapters	Review and reflection	all chapters

## Getting Help

1. Your best source of help is your tutorial/lab instructor during the tutorial/lab period.
2. The course professors will be available to provide help online **during their posted office hours**. These will be announced in class and are posted on Courselink. If you wish to obtain help from your professor at another time, please arrange a mutually convenient time via e-mail .
3. Computer Tutorials: There are a number of physics tutorials available for you on the Physics Department tutorial webpage

*[www.physics.uoguelph.ca/tutorials/tutorials.html](http://www.physics.uoguelph.ca/tutorials/tutorials.html)*

Of particular usefulness in this course are the tutorials on: Algebra (review), Significant Digits Unit Conversions Trigonometry (review), Free-Body Diagrams Graphing Log Paper Vectors (review), Torque and Rotational Motion, Dimensional Analysis, and Simple Harmonic Motion

## Tentative Physics Tutorial/Lab Schedule:

Week	Dates (Tu/Wed/Th)	Tutorial/Lab	Location
1	Sept. 14-18	Tutorial 1: Introduction to IO Labs	online (synchronous)
2	Sept. 21-25	Lab 1: Motion and uncertainty	online (synchronous)
3	Sept. 28-Oct. 2	Tutorial 2, Physics Quiz 1	online (synchronous)
4	Oct. 5-9	Lab 2: Error propagation in a pendulum, Case Study handed out	online (synchronous)
5	Oct. 12-Oct. 16	Holiday Mon/Tue No Tutorial/Lab, <b>Midterm Help Sessions</b>	online (synchronous)
6	Oct. 19-Oct. 23	Midterm week, no Tutorial/Lab	online (synchronous)
7	Oct. 26-30	Lab 3: Forces and Atwood's machine	online (synchronous)
8	Nov. 2-6	Tutorial 3, Quiz 2	online (synchronous)
9	Nov. 9-13	Case Study Help Session	online (synchronous)
10	Nov. 16-20	Lab 4: Torque and Angular Momentum, <b>Case Study Due</b>	online (synchronous)
11	Nov. 23-27	Tutorial 4, Quiz 3	online (synchronous)
12	Dec. 30-04	Final Exam Review Sessions (TBA)	online (synchronous)

## Rights and Responsibilities

**Check your University E-mail, and Keep Copies of Everything** We mostly put stuff on Courselink for this course, but emergencies and big changes may get to you first via university e-mail. Sometimes, homeworks get lost and quiz grades are not recorded correctly. Please keep copies of any assignments you hand in and keep a folder with all your work in case there is a problem.

**Accommodation and use of the SAS exam center** Students requiring accommodation must register with SAS to receive accommodation. Examinations in the SAS center must be booked at least a week in advance and before the 40th day of class.

**Conflicts with Midterms in Other Courses.** Sometimes students will have a conflict between a midterm exam in another course and either a lecture or a lab in this course. The University has a very clear policy to cover this situation: the regularly-scheduled lecture or lab holds priority. In other words, it is the responsibility of the faculty member who has scheduled the midterm exam to make special arrangements with students who have conflicts. This policy is stated explicitly in the 2020-2021 Undergraduate Calendar <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/> in Section VIII–Undergraduate Degree Regulations and Procedures under the heading *Examinations* (sub-heading *Mid-Term Examinations*).

**Attendance: Illness, etc.:** Attendance at the tutorial/lab periods is, of course, very important. If you miss a tutorial quiz because of illness or for compassionate reasons, please see your laboratory/tutorial instructor for possible academic consideration. If you miss the midterm exam, please contact a course professor. If you miss the final exam, please contact your Program Counsellor. For more details, refer to the Undergraduate Calendar: <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/> – go to *Section VIII Undergraduate Degree Regulations and Procedures*, and click on the heading *Academic Consideration, Appeals and Petitions*.

**Collaboration:** This course encourages collaborative teamwork, a skill that is an essential feature of science, and valued by most employers. Scientists and engineers work in groups as well as alone. Social interactions are critical to their success! Most good ideas grow out of discussions with colleagues. As you study together, help your partners to get over confusions, ask each other questions, and critique your assignments and lab write-ups. Teach each other. You can learn a great deal by teaching. While students are encouraged to share ideas, all material submitted for grading must be each student's own work. Plagiarism is a form of academic misconduct, and will not be tolerated.

**Course Feedback:** Both sponsoring departments require student assessments of all courses taught by the departments. These assessments provide essential feedback to faculty on their teaching by identifying both strengths and possible areas of improvement. In addition, annual student assessment of teaching provides part of the information used by the department's Tenure and Promotion Committee in evaluating the faculty member's contribution in the area of teaching. The department's teaching evaluation questionnaire invites student response both through numerically quantifiable data, and written student comments. In conformity with University of Guelph Faculty Policy, the department's Tenure and Promotions Committee **only considers comments signed by students (choosing "I agree" in question 14)**. Your instructor will see all signed and unsigned comments after final grades are submitted. Written student comments may also be used in support of a nomination for internal and external teaching awards. NOTE: No information will be passed on to the instructor until after the final grades have been submitted.

**Electronic Recording of Classes:** The electronic recording of classes is expressly forbidden without the prior consent of the instructor. This prohibition extends to all components of the course, including, but not limited to, lectures, tutorials, and lab instruction, whether conducted by the instructor or teaching assistant, or other designated person. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

### **Academic Misconduct**

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community, faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor. The **Academic Misconduct Policy** is detailed in the Undergraduate Calendar: <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/>

### **Accessibility**

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact Student Accessibility Services as soon as possible. For more information, contact **519-824-4120 ext. 56208** or email [sas@uoguelph.ca](mailto:sas@uoguelph.ca) or see the website: <http://www.csd.uoguelph.ca/csd/>

### **Drop date**

The last date to drop one-semester courses, without academic penalty, is Friday, Dec. 4th, 2020. For regulations and procedures for Dropping Courses, see the Academic Calendar:

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>