PHY293H1F – WAVES AND MODERN PHYSICS
DEPARTMENT OF PHYSICS UNIVERSITY OF TORONTO
Course Syllabus: FALL 2020 – Updated Sept. 15

This course is taught as two consecutive sections: Waves (Sep. 11 - Oct. 21) and Modern Physics (Oct. 23 - Dec. 9). The general course, tutorial and laboratory information is given on this page. The individual syllabi for the two sections are given on the following pages.

Course Website: on Quercus and https://www.physics.utoronto.ca/undergraduate/undergraduate-courses/waves-and-modern-physics/.

Course Coordinator and Lab Coordinator:
Dr. Matt Russo
Office: Online, by request
Email: mrusso@physics.utoronto.ca
Please contact the course coordinator on matters relating to course administration, e.g. grading.

Lecturers:
Part A, "Waves and Oscillations": Prof. Nicolas Grisouard
Office: Online, by request
Office Hours: Mondays, 10 am, on BlackBoard Collaborate
E-mail: nicolas.grisouard@utoronto.ca

Part B "Modern Physics": Prof. Pekka Sinervo, C.M.,
Office: Online, by request
Office Hours: Mondays, 10 am, on BlackBoard Collaborate
E-mail: pekka.sinervo@utoronto.ca

Tutorial Instructors:

Tutorial TA	Email
Shayne Gryba	sgryba@physics.utoronto.ca
Joseph McGowan	jmcgowan@physics.utoronto.ca
Kristen Cote	kcote@physics.utoroonto.ca
Sreekar Voleti	svoleti@physics.utoronto.ca

Marking Scheme:

Six Tutorial Quizzes	50 %	30 minutes each
Laboratories	20 %	Three Lab Reports
Final Project	30 %	During final assessment period

All coursework listed in this marking scheme is mandatory.

Lectures:
Profs. N.G., then P.S., will conduct lectures 3 times/week through Blackboard Collaborate. Both sections meet at the same time. The first lecture is on Friday, Sep. 11.

The lectures for this course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session. Course videos and materials belong to your instructor, the University, and/or other source depending on the specific

facts of each situation, and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

Section	Tuesday	Wednesday	Friday
LEC0101 LEC0102	1pm	4pm	10am

WAVES SECTION

Lecturer: Prof. Nicolas Grisouard
TEXTBOOK: "Vibrations and Waves" by George C. King (Publisher: Wiley), available as an ebook here: http://go.utlib.ca/cat/13143325

COURSE NOTES: Course notes will be posted to Course Materials on Quercus and also at https://github.com/PHY293-Grisouard/Chapters-2020.

Week #	Lecture Date	Topic	Textbook Reference
1	September 11	Intro + Simple harmonic oscillators	Chapter 1
1	September 15	Simple harmonic oscillators: energy + intro to damping	Chapter 1
1	September 16	Over-, under- and critically damped harmonic oscillators	Chapter 2
2	September 18	Damped harmonic oscillators: energy and Q-factor	Chapter 2
2	September 22	Driven oscillators and resonance	Chapter 3
2	September 23	Driven, damped harmonic oscillators: resonance curve, transients	Chapter 3
3	September 25	Power curve, LRC circuit	Chapter 3
3	September 29	Coupled pendulums; beating	Chapter 4
3	September 30	Coupled pendulums as an eigenvalue problem	Chapter 4
4	October 2	Orthogonality of the normal modes; from two to n coupled oscillators	Chapter 4
4	October 6	The wave equation; standing waves on a taut string	Chapters 5, 6
4	October 7	Orthogonality of the standing wave modes; initial value problems theory	Chapter 6
5	October 9	Initial value problems: examples and illustrations; energy	Chapter 6
5	October 13	Travelling waves as a superposition of modes; general solution	Chapter 5
5	October 14	Energy of traveling waves; reflection and transmission	Chapter 5
6	October 16	Wave dispersion	Chapter 8
6	October 20	Examples of dispersive behaviour	Chapter 8
6	October 21	Wave Packets	Chapter 8

MODERN PHYSICS SECTION

Lecturer: Prof. Pekka Sinervo, C.M.
TEXTBOOK: Quantum Mechanics, 6th edition by Alastair I.M. Rae & Jim Napolitano (CRC Press)
COURSE NOTES: Course notes will be posted to Course Materials on Quercus.

Week #	Lecture Date	Topic	Textbook Reference
7	October 23	Introduction to Modern Physics	Sections 1.1-2, 2.1-5
7	October 27	Introduction to Special Relativity	Sections 3.1, 3.2
7	October 28	Lorentz transformations	Sections 3.3
8	October 30	Paradoxes in SR, Relativistic Doppler shift	Lecture Notes
8	November 3	Four-vectors, Lorentz invariants, Relativistic Energy and Momentum	Lecture Notes
8	November 4	Light cones, relativistic kinematics	Lecture Notes
9	November 6	Introduction to Quantum Mechanics	Sections 4.1, 4.2
	Nov 9-13	*Reading Week*	
9	November 17	Photo-electric effect and Compton effect	Sections 4.1, 4.2
9	November 18	Atomic spectra	Section 4.3
10	November 20	de Broglie waves	Section 4.4
10	November 24	Wave-particle duality	Section 4.5
10	November 25	Heisenberg Uncertainty Principle	Section 4.5
11	November 27	The Schrödinger equation and wave functions	Section 5.1
11	December 1	Time-independent Schrödinger equation	Sections 5.2, 5.3
11	December 2	Particle in an infinite square well potential	Section 5.4
12	December 4	Finite square well potential	Sections 5.5, 5.6
12	December 8	Simple harmonic oscillator	Section 5.7
12	December 9	Interpretations of the wave function	Lecture Notes

Tutorials and Quizzes

Section	Day	Time	TA
TUT0101	Tues	11am - noon	Kristen Cote
TUT0102	Tues	11am - noon	Shayne Gryba
TUT0103	Mon	4pm - 5pm	Joseph McGowan
TUT0104	Mon	4pm - 5pm	Shayne Gryba
TUT0105	Thurs	noon- 1pm	Sreekar Voleti
TUT0106	Thurs	noon – 1pm	Joseph McGowan
TUT0107	Thurs	11 am - noon	Sreekar Voleti
TUT0108	Thurs	11 am - noon	Kristen Cote

- For the tutorials, a set of suggested problems will be posted before each week's tutorial sessions. One of the TAs will prepare a video solution to one or more of the problems and full written solutions for all problems will be posted.
- The tutorials will be conducted as live Q & A sessions through Blackboard Collaborate where you can discuss the posted practice problems and solutions with your TA and classmates. These sessions will not be recorded.
- All but one of the quizzes will happen during the Monday or Thursday test periods. This is purely for convenience. These are quizzes, not tests. Quiz 5 will be held in the last 30min of your regularly scheduled Tutorial 9, (the Q&A session will end early that day).
- If you have to miss a quiz you can submit a petition on the EngSci portal. If the petition is approved by the Division of Engineering Science, the quiz will be recorded as an excused absence and the weighting of your other quizzes will be increased to compensate.
- If you know in advance that you won't be able to attend a tutorial session, contact the coordinator (Matt Russo) about switching into a different section for that week only.

Week	**Tutorial #**	**Dates**	**Notes**
1			First lecture on Sep 11. No tutorials this week.
2	1	Sept. 17, 21, 22	
3	2	Sept. 24, 28, 29	
4	3	Oct. 1, 5, 6	
5	4	Oct. 8, 13	No tutorials Thanksgiving Monday
6	5	Oct. 15, 19, 20	
7	6	Oct 22, 26, 27	Part II starts on Oct 23
8	7	Oct. 29, Nov 2, 3	
9	8	Nov. 5, 16, 17	Nov 9-13 Fall Reading Week. No classes.
10	9	Nov. 19, 23, 24	
11	10	Nov. 26, 30, Dec. 1	
12	11	Dec. 3, 7, 8	

Quiz	Date(s)	Time
1	Thurs. Sept. 24	10:30am
2	Thurs. Oct. 8	10:30am
3	Mon. Oct. 19	10:30am
4	Mon. Nov. 2	10:30am
5	Nov. 19/23/24	During your tutorial, 30min past the hour
6	Mon. Dec. 7	10:30am

Laboratories (Practicals)
All of the information regarding practicals can be found on the Practicals Quercus page (which is separate from the Quercus page for the Lectures and Tutorials).

- This term, **the practicals will be completely asynchronous, with no scheduled in-person component.**
- You will be provided with videos of your TAs demonstrating the experiments as well as the raw data that they collect.
- After reading the experiment manual, you will watch the video, analyze and interpret the data, and then complete a written report.
- Reports will be written in pairs. You will complete a survey early in the term to indicate if you've chosen a partner or not. If not, you will be paired with someone.
- The first assignment is the Resistance Exercise which is designed to help you practice error analysis skills.
- In early October, the full list of experiment options will be posted and you will submit your preferences for the two experiments that you and your partner would like to write reports on. These are called Lab1 and Lab 2.
- One report will be on a '1-weight' experiment, the other will be a more complex '2-weight' experiment.
- One of your chosen experiments will relate to waves and the other will relate to modern physics, fundamental constants, or classic experiments.

Your reports will be analyzed by Turnitin.com (see "Academic integrity"). The due dates for your written reports will depend on which of your reports is 1-weight and which is 2-weight (Schedule 1 or Schedule 2):

Date	**Schedule 1**	**Schedule 2**
Oct. 14	Resistance Exercise	Resistance Exercise
Oct. 28	Lab 1 (1-weight)	N/A
Nov. 18	N/A	Lab 1 (2-weight)
Dec. 2	Lab 2 (2-weight)	Lab 2 (1-weight)

The TAs who will be demonstrating the experiments, answering your questions about them, and marking your reports are:

TA/Lab Demonstrator	**e-mail address**
Paul Jeffery	pjeffery@physics.utoronto.ca
Nishant Bhatt	nbhatt@physics.utoronto.ca
Haruki Hirasawa	hirasawa@mail.utoronto.ca
Kenneth Jackson	kjackson@physics.utoronto.ca

Chao (Charles) Zhang	czhan1@physics.utoronto.ca
Rainni Chen	rainchen@physics.utoronto.ca

Quizzes
Quizzes will assess your individual mastery of the course content. They will happen on Quercus and will be timed (30 minutes). You can use your notes and the instructor's notes for help, but no external sources such as websites, textbooks (including your course's textbooks), or else. We insist that Quizzes must be done individually, involving no communication at all with your peers or consultations with external sources.

We will treat any violation of the rules highlighted in this document (see "Academic integrity" below), and in the Code, as academic misconduct. The University of Toronto treats cases of academic misconduct very seriously. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code. The consequences for academic misconduct can be severe, including a failure in the course and a notation on your transcript. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact the course coordinator. If you are experiencing personal challenges that are having an impact on your academic work, please speak to the course coordinator or seek the advice of your college registrar.

Final Project

As your comprehensive, final assessment, you will write two final projects, one for each half of the course. These projects will be due on December 22nd, 2020, i.e., the last day of the final assessment period. Near the middle of term (late October), will provide you with:

- Two lists of about 20 subjects, one for each ½ of the course. Each of you will choose one project in each list. **You are free to propose your own subject but ask your instructor first!** For each list, we will divide the class into groups of equal sizes. For example, if part A proposes 20 subjects, we will set up groups with maximum enrollment of 13 people (13x20=260, as there are 251 of you) to evenly spread the students among topics. You are free to discuss the topic within a group, but you will hand in an individual copy. Remember that we will analyze similarities across copies with Turnitin.com (see "Academic integrity" below)!
- A list of questions to answer.
- A short list of references to start your bibliographic search.
- A list of UofT resources to improve your writing skills, should you require them.
- Specific formatting instructions (length, font size, etc).

Instructors Email Policy
General questions that refer to physics being discussed in the course should be posted to the course discussion board on Quercus or Piazza – please check your utoronto email address for instructions on how to log in (starting this year, piazza will be accessible directly via Quercus). We will

generally provide feedback on these within 48 hours. Only if this fails to resolve your issue should you email one of the instructors directly for further clarification, or to set up an appointment to delve deeper into your question. Instructors **will not** answer administrative questions (about grades, due dates or material covered in tests of exams) by email.

Academic Integrity, adapted from the Academic integrity web page of the University of Toronto: Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:
In papers and assignments:

1. Using someone else's ideas, words or mathematical solutions without appropriate acknowledgement;
2. Submitting your own work in more than one course without the permission of the instructor;
3. Making up sources or facts;
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids;
2. Looking at someone else's answers during an exam or test;
3. Misrepresenting your identity; and
4. When you knew or ought to have known you were doing it.

In academic work:

1. Falsifying institutional documents or grades;
2. Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes; and
3. When you knew or ought to have known you were doing so.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If students have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, they are expected to seek out additional information on academic integrity from their instructors or from other institutional resources.

Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

In this course, we will use Turnitin.com for your lab reports, your final projects, and any other assignment we deem Turnitin.com relevant for. Note that Turnitin does not make any decision, it just

sends us a report, but it is up to your marker to decide if the passages highlighted by the tool represent plagiarism.

Accommodations
If you have a learning need requiring an accommodation the University of Toronto recommends that students immediately register at Accessibility Services at http://www.studentlife.utoronto.ca/as.

Location: 4th floor of 455 Spadina Avenue, Suite 400

Phone: 416-978-8060

Email: accessibility.services@utoronto.ca

The University of Toronto supports accommodations of students with special learning needs, which may be associated with learning disabilities, mobility impairments, functional/fine motor disabilities, acquired brain injuries, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, psychiatric disabilities, communication disorders and/or temporary disabilities, such as fractures and severe sprains, recovery from an operation, serious infections or pregnancy complications.

Equity, Diversity and Excellence
At the University of Toronto, we strive to be an equitable and inclusive community, rich with diversity, protecting the human rights of all persons, and based upon understanding and mutual respect for the dignity and worth of every person. We seek to ensure to the greatest extent possible that all students enjoy the opportunity to participate as they see fit in the full range of activities that the University offers, and to achieve their full potential as members of the University community.

Our support for equity is grounded in an institution-wide commitment to achieving a working, teaching, and learning environment that is free of discrimination and harassment as defined in the Ontario Human Rights Code. In striving to become an equitable community, we will also work to eliminate, reduce or mitigate the adverse effects of any barriers to full participation in University life that we find, including physical, environmental, attitudinal, communication or technological.

Our teaching, scholarship and other activities take place in the context of a highly diverse society. Reflecting this diversity in our own community is uniquely valuable to the University as it contributes to the diversification of ideas and perspectives and thereby enriches our scholarship, teaching and other activities. We will proactively seek to increase diversity among our community members, and it is our aim to have a student body and teaching and administrative staffs that mirror the diversity of the pool of potential qualified applicants for those positions.

We believe that excellence flourishes in an environment that embraces the broadest range of people that helps them to achieve their full potential, that facilitates the free expression of their diverse perspectives through respectful discourse, and in which high standards are maintained for students and staff alike. An equitable and inclusive learning environment creates the conditions for our student body to maximize their creativity and their contributions, thereby supporting excellence in all dimensions of the institution.

Statement on Mental Health and Wellness

As a university student, you may experience a range of health and/or mental health issues that may result in significant barriers to achieving your personal and academic goals. The University of Toronto offers a wide range of free and confidential services and programs that may be able to assist you.
As a U of T Engineering student, you have an Academic Advisor (undergraduate students) or a Graduate Administrator (graduate students) who can support you by advising on personal matters that impact your academics. Other resources that you may find helpful are listed on the U of T Engineering Mental Health & Wellness webpage, and a small selection are also included here:

- Accessibility Services & the On-Location Advisor
- Graduate Engineering Council of Students' Mental Wellness Commission
- Health & Wellness and the On-Location Health & Wellness Engineering Counsellor
- Inclusion & Transition Advisor
- U of T Engineering Learning Strategist and Academic Success
- My Student Support Program (MySSP)
- Registrar's Office
- SKULE Mental Wellness
- Scholarships & Financial Aid Office & Advisor

If you find yourself feeling distressed and in need of more immediate support resources, consider reaching out to the counsellors at My Student Support Program (MySSP) or visiting the Feeling Distressed webpage.

Land Acknowledgement
We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.