# Physics 2218 - Physics III: Waves and Thermal Physics

Fall 2022

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| Lectures | MWF | 11:20–12:10 PM | RK 230 | Peter Wittich<br>397 PSB 5-3368<br>wittich@cornell.edu |
| Section | T<br>W | 1:30 – 2:20 PM<br>2:40 – 3:30 PM | Clark 294D<br>Clark 294A | Yikun Jiang<br>PSB 4th floor<br>yj366@cornell.edu |
| Grader | | | | Maciej Olszewski<br>mwo34@cornell.edu |

- Content:
  This course is divided into two parts. The larger segment of the course focuses on wave phenomena. Topics include coupled harmonic oscillators, strings, sound and light waves, superposition principle, wave equations, Fourier series and transforms, diffraction and interference. The discussion is at the level of *The Physics of Waves* by Georgi. The second segment of the course covers thermodynamics and statistical mechanics at the level of Thermal Physics by Schroeder.

- Prerequisites

  Co-requisite: PHYS 2210. Prerequisite: PHYS 2217 or very strong performance in PHYS 2213. Students would benefit from prior exposure to differential equations at the level of MATH 2930 or from co-registration in that course. Some linear algebra may be used, either prior or concurrent enrollment in linear algebra is recommended (MATH 2940, MATH 2210, or MATH 2230).

- Books:

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| *Physics of Waves* | H. Georgi | *Required* |
| *Vibrations and Waves* | A.P. French | *Required* |
| *Physics of Vibrations and Waves* | H.J. Pain & P. Rankin | *Required* |
| *Thermal Physics* | D.V. Schroeder | *Required* |

  The waves book by Georgi is available for free on the web (https://sites.harvard.edu/hgeorgi/files/2022/04/onenew.pdf) and will be linked on canvas. The other textbooks should all be available through CAMP as e-books.

- Online tools:

  We will be using Canvas for this class. You should be automatically enrolled in the course for Physics 2218, unless you are auditing. We will be sending out announcements via the linked email account so make sure to check it regularly.

  We will also use Ed Discussions for crowd-sourced discussions. This is integrated into Canvas. Finally, we will be using GradeScope for grading assignments.

- Homework and Grade Policy
  In addition to weekly homework, there will be a prelim and a final exam. Your final grade will be composed of participation, section, homework, and exam scores.

  Homework will be distributed on Fridays and will be due a week later, all via GradeScope. Homework must be submitted by 11:59 PM.

  You have two late days for use during the semester, no questions asked; after that, late homework will not be accepted. You should not underestimate the importance of working every homework problem. These late days are intended to cover emergencies such as sickness, emergency travel, etc, so use the wisely. You must ask for the extension **before** the due date. Message the teaching staff, and we will create an extension for you on GradeScope.

  When you use an extension, the homework will be due at 11:59 PM at the end of the next business day (i.e., for a homework due on Friday, the new due date would be 11:59 PM on Monday.)

  For regrade requests, please re-submit your homework via GradeScope with a written request or explanation. It will be returned to you the following week.

  For the homework, I encourage you to work in groups; however, the final homework you turn in should be your own.

- Academic Integrity

  Cornell takes issues of academic integrity extremely seriously. Integrity and honesty will be absolutely essential in your future careers. Students who are found in violation of Cornell's Code of Academic Integrity can expect to be prosecuted to the full extent allowed by the code. Some examples of violations for which we have prosecuted students in the recent past:

  - Turning in homework that has been copied from another student or downloaded from the internet. Working in groups is encouraged; however, your write-up must be your own.
  - Copying the work of another student during a quiz or exam.
  - Using cheat sheets, notes written on body appendages, clothing and hats, or programmed calculators during a quiz or exam.
  - Changing an answer on a quiz or exam after it has been graded and submitting it for a regrade.
  - Providing false reasons (e.g., illness, death in the family, interviews, and athletic events) for missing a quiz or exam. Proper documentation must be provided.
  - Providing false reasons in requesting a make-up exam. Proper documentation must be provided.
  - Copying material from sources such as Wikipedia without proper attribution or citations. Working with references is crucial in science so you should be familiar with it.

  No matter how desperate your situation may seem, you should never violate the code of academic integrity and never make misrepresentations to your TA or your professors. Come talk to your me, your TA, or your advising dean for advice on how to resolve your difficulties.

  See the Cornell Code of Academic Integrity online for more information.

- ***Grading*** Below please find a grade breakdown.

| | % |
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| HW<br>Participation<br>Section | 1/3 |
| Prelim | 1/3 |
| Final | 1/3 |

  Participation includes any in-class handouts.

## Tentative Syllabus

| Lect | Date | Topic | Reading |
|---|---|---|---|
| | | Wave Phenomena | |
| 0 | 08/22 | Simple Harmonic Oscillators 1 | G1-G2, F3, P1 |
| 1 | 08/24 | Simple Harmonic Oscillators 2 | G1-2, F3, P1 |
| 2 | 08/26 | Damped Harmonic Oscillators | G2, F3, P2 |
| 3 | 08/29 | Quality factors and driven, damped oscillators | G5, F4, P3 |
| 4 | 08/31 | Coupled scillators and normal modes | G5, F5, P4 |
| 5 | 09/02 | Many coupled oscillators/beaded string | G5, G10, F6 |
| | 09/05 | Labor Day | |
| 6 | 09/07 | Beaded String to continuous string | G5, F6 |
| 7 | 09/09 | Exploring the wave equation I | G5, F7, P5-6 |
| 8 | 09/12 | Exploring the wave equation II | G6, F7, P5-6 |
| 9 | 09/14 | Group and phase velocity | F7, P5 |
| 10 | 09/16 | Energy & Power in Waves | G7-8 |
| 11 | 09/19 | Fourier Series | G6, F6, P11 |
| 12 | 09/21 | Fourier Transform | G6, F6, P11 |
| 13 | 09/23 | Longitudinal Waves, slinky | G7, P7 |
| 14 | 09/26 | Longitudinal waves, solid rod | G7, P7 |
| 15 | 09/28 | Longitudinal waves, sound (pressure waves) | G7, P7 |
| 16 | 09/30 | Intensity in Sound Waves, Waves in 3 dimensions | G7, P10 |
| 17 | 10/03 | Electromagnetic Waves as 3d waves | G8, P9 |
| 18 | 10/05 | Transmission and reflection I | G9, F8, P5 |
| 19 | 10/07 | Transmission and reflection II | G9, F8, P7 |
| | 10/10 | Fall Break | |
| 20 | 10/12 | Transmission and reflection III | G9, F8, P5-P7 |
| 21 | 10/14 | Diffraction Gratings & Thin Films | G13, F8, P13 |
| 22 | 10/17 | Diffraction by Circular Apertures | G13, F8, P13 |
| | 10/18 | Prelim | |
| 23 | 10/19 | Diffraction by Multiple Slits | G13, F8, P13 |
| 24 | 10/21 | Huygens Principle and Fraunhofer Diffraction | G13, F8 |
| 25 | 10/24 | Interference from Multiple Sources | G13, F8, P12 |
| 26 | 10/26 | Amplitude Modulation and Radio xmission | |
| 27 | 10/28 | Interferometers, Doppler Effect | |
| | | Thermodynamics | |
| 28 | 10/31 | Thermal Physics, Temperature & Heat | 1-14 |
| 29 | 11/02 | Ideal Gas Law, Equipartition Theorem | 1-17 |
| 30 | 11/04 | First Law of Thermodynamics | 17-31 |
| 31 | 11/07 | State Variables, Heat Capacity | 28-33 |
| 32 | 11/09 | Enthalpy, Latent Heat, Phases/Phase Transitions | 33-37 |
| 33 | 11/11 | Microstates and Macrostates | 49-67 |
| 34 | 11/14 | Second Law of Thermodynamics, Einstein Solids | 49-67 |
| 35 | 11/16 | Entropy, Thermal Equilibrium and 2nd law | 49-67 |
| 36 | 11/18 | Entropy of Ideal Gas, Disorder, Reversiblity | 67-84 |
| 37 | 11/21 | Heat Engine | 122-148 |
| | 11/23 | Thanksgiving | |
| | 11/25 | Thanksgiving | |
| 38 | 11/28 | Carnot Cycle, other heat engines | 122-148 |
| 39 | 11/30 | Second Law revisited | |
| 40 | 12/02 | Thermodynamic Potentials | |
| | | other | |
| 41 | 12/05 | Overflow and Exam prep | |