Physics and Astronomy

General Course Information

PHYS205
Waves, Optics and Mechanics

0.125 EFTS 15 Points
First Semester

Course Coordinator and Lecturer (weeks 7-12)
Professor Jon-Paul Wells
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Lecturer (weeks 1-6)
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Description
This course will provide a deeper understanding of mechanics than addressed at 100-level, particularly the motion of rotating bodies and the application of these ideas to real-world systems such as the weather and orbits.

We will study the physics of wave oscillations and their applications in numerous different physical systems. The geometric theory of image formation is developed and applied to various optical instruments. We will study interference and diffraction phenomena, as well as optical instruments such as diffraction grating spectrometers, interferometers and lasers.

Assessment

20%	10 Homework Assignments (best nine to count) handed into the PHYS205 dropbox on learn.
5%	Attendance and participation in a minimum of 10 tutorials.
25%	Two in term tests. Term 1: Monday March 16th, 7-8 pm (evening slot). Term 2: Wednesday May 13th, 4-5 pm (normal lecture slot).
50%	Final Examination

The following shall apply for *all assessments in this course*, except where the lecturer has specifically stated otherwise *in written instructions for an assessment.*

Use Prohibited for Specified Reasons: Generative AI tools must not be used within this assessment due to specific considerations, which will be clearly communicated to students.

Generative AI Tools Cannot Be Used for This Assessment
In this assessment, you are strictly prohibited from using generative artificial intelligence (AI) to generate any materials or content related to the assessment. This is because *students are expected to solve problems and demonstrate knowledge and understanding without the assistance of AI*. The use of AI-generated content is not permitted and may be considered a breach of academic integrity. Please ensure that all work submitted is the result of your own human knowledge, skills, and efforts.

Pre-requisites
P: (1) PHYS 102; (2) MATH102 or EMTH118 (3) COSC131 or COSC121
RP: MATH103 or EMTH119
R: PHYS221, PHYS201, PHYS202
These prerequisites may be replaced by a high level of achievement in NCEA Level 3 Physics and Mathematics with Calculus or other background as approved by the Head of Department.

Textbooks
Recommended texts include:
H.J. Pain, *The Physics of Vibrations and Waves,* John Wiley and Sons
C. Kittel et al., *Mechanics* (Berkeley Physics Course), McGraw-Hill.
I.G. Main, *Vibrations and Waves in Physics,* Cambridge University Press
E. Hecht, *Optics,* Addison-Wesley
F. Smith, T. King, D. Wilkins, *Optics and Photonics*, John Wiley and Sons
R. Serway, J. Jewett, *Physics for Scientists and Engineers with Modern Physics,* Thomson

Goal of the Course
The goal of this course is to provide a thorough knowledge of mechanics, the physics of wave oscillations, geometric and physical optics for students graduating with a physics major.

Learning Outcomes
Students will:
(1) Be able to describe the motion of an object due the relationship between Force and Potential Energy
(2) Be able to relate Angular Momentum, Torque and Kepler's Laws for objects in orbits
(3) Be able to explain the different types of reference frames
(4) Be able to solve problems in collisions and rotating frames by transformations to reference frames
(5) Have acquired an understanding of the importance of wave phenomena in the physical world.
(6) Have mastered the mathematical formalism used to describe oscillatory systems.
(7) Be able to solve imaging problems in geometric optics.
(8) Be able to solve diffraction problems in physical optics
(9) Be familiar with key modern developments in optics
(10) Have developed and be able to demonstrate competency to solve appropriate physics problems in the concepts of the course. (exam and assignment assessment)..
(11) Demonstrate competency to solve appropriate physics problems in the concepts of the course (exam and assignment assessment).
(12) Demonstrate writing and associated communication skills (exam and assignment assessment).

Notes
Electronic copies of the detailed lecture notes will be available on the Learn system after week two: http://learn.canterbury.ac.nz/

Late Work
Late work is not in general acceptable without a medical certificate.

Marks and Grades: The following numbers should be considered as a guide to the expected grades under normal circumstances. The School reserves the right to adjust mark/grade conversions, if necessary.

Please note that for all invigilated assessments (tests and exams) worth 33% and above, failure to obtain a mark of at least 40% will result in a final grade no higher than an R at 100 and 200 level, and a C- at 300 level.

Grade:	**A+**	**A**	**A−**	**B+**	**B**	**B−**	**C+**	**C**	**C-**	**D**	**E**
Minimum mark %:	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**40**	**0**

Summary of Course Content

Part 1. Mechanics

1. Potentials and Forces: Newtonian gravity, momentum conservation
2. Angular momentum & Torque: Kepler's Laws, central forces and orbits.
3. Rigid bodies: Moments of inertia, rotating bodies.
4. Collisions: Frames of reference, elastic and inelastic collisions
5. Rotating frames. Motion in non-inertial frames, Coriolis and centrifugal forces. Rotating weather systems.

Part 2. Waves and Optics

1. Free Oscillations, simple harmonic motion. Equations of motion, examples: simple pendulum, LC circuits.
2. Damped oscillators. Light damping: amplitude decay (log decrement), energy loss (Q factor), resonant frequency shifts. LRC circuits, collision damping in metals. Heavy and critical damping.
3. Forced vibrations. The equation of motion with a driving term. Resonance and power absorption.
4. Coupled oscillators, mode co-ordinates, normal modes.
5. Travelling waves, the wave equation, phase and group velocity.
6. Orthogonal vibrations, electromagnetic waves and polarisation. Malus' law.
7. Reflection and refraction. Hugyen's and Fermat's principles. Snell's law. Dispersion and total internal reflection. Prisms. Minimum angle of deviation
8. Refraction at a spherical interface. The thin lens equations. Magnification. Ray tracing diagrams. Combinations of lens. Spherical mirrors. Prisms.
9. Fraunhofer diffraction pattern of a single slit.
10. Young's double slit experiment. Missing orders of interference.
11. The Fabry-Perot interferometer, lasers and Fabry-Perot cavities.