Physics and Astronomy

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

General Course Information

PHYS205
Waves, Optics and Mechanics

0.125 EFTS 15 Points
First Semester

Lecturer (weeks 1-6)
Professor Jenni Adams
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Course Coordinator and Lecturer (weeks 7-12)
Professor Jon-Paul Wells
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Timetable:

Weeks 1-12 (22^{nd} Feb – 4^{th} Apr, 26^{th} Apr – 6^{th} Jun)
Lectures: Mon 4 pm (Rehua103), Tues 10 am (E16), Thurs 12 pm (E16)
Tutorial: Friday 10:00 am (Ernest Rutherford 319,320)

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 in every week via learn.
5%	Attendance and participation in a minimum of 10 tutorials
25%	Two in term tests.
	Term 1: Tuesday March 23^{rd}, 10 am (normal lecture time). Term 2: Thursday May 20^{th}, 12 pm (normal lecture time).
50%	Final Examination

Pre-requisites
P: (1) PHYS 102; (2) MATH102 or EMTH118
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) Have gained a thorough knowledge of the motion of orbits and rotating bodies and understand how to make use of rotating frames of reference to determine the motion of objects on the surface of the Earth.
(2) Have acquired an understanding of the importance of wave phenomena in the physical world.
(3) Have mastered the mathematical formalism used to describe oscillatory systems.
(4) Be able to solve imaging problems in geometric optics.
(5) Be able to solve diffraction problems in physical optics
(6) Be familiar with key modern developments in optics
(7) Have developed and be able to demonstrate competency to solve appropriate physics problems in the concepts of the course. (exam and assignment assessment)..
(8) Demonstrate competency to solve appropriate physics problems in the concepts of the course (exam and assignment assessment).
(9) 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.

Summary of Course Content

Part 1. Mechanics

1. Linear momentum. Frames of reference, momentum conservation
2. Angular momentum, central forces and orbits.
3. Rigid bodies. Moments of inertia, rotating bodies and gyroscopes.
4. Rotating frames. Motion in non-inertial frames, Coriolis and centrifugal forces. Projectile motion and weather.

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
9. Thick lenses, beam expanders, telescopes and compound microscopes.
10. Optical fibres. Maximum acceptance angles and losses. Single mode fibres.
11. Fraunhofer diffraction pattern of a single slit.
12. Young's double slit experiment. Missing orders of interference.
13. The Fabry-Perot interferometer, lasers and Fabry-Perot cavities.