

DEPARTMENT OF PHYSICS AND ASTRONOMY
TRENT UNIVERSITY

PHYS 4240H: Modern Optics
2014-2015 WI
Peterborough

Instructor: Aaron Slepkov	Email: aaronslepkov@trentu.ca	Telephone: x6216
Campus: Peterborough	Office Location: SC211	Office Hours: Thursdays 10:00-11:30 AM and/or by appointment

Secretary: Gina Collins	Email: gcollins@trentu.ca
Office Location: SC327	Telephone: x7715

This course is being co-offered by remote link to UOIT students (PHY 4240T/73681). Location for lectures and seminars at UOIT are tentative only and changes in such locations are not the responsibility of Trent University. All registered UOIT students are responsible for alerting the instructor to any changes or scheduling difficulties at the UOIT end.

Course Description:

The goal of this course is designed to provide a foundational survey in optics, beginning with Maxwell's equations and fundamental properties of electromagnetic radiation and then applying these properties to phenomena such as reflection/refraction, interference, coherence, absorption/emission, and laser operation. The course answers the basics of "what is light, how is light made, and how is light used?"

Required Texts: *Introduction to Optics*, by Pedrotti, Pedrotti, and Pedrotti. (3rd edition preferred)
Recommended Reading: *Optics*, 4th edition, Eugene Hecht.

Course webpage: A blackboard course is set up for PHYS-4240H-A-W01-2015WI-PTBO Modern Optics, accessible via www.learn.trentu.ca

Course Format: Please check www.trentu.ca/timetable/ to confirm times and locations.

	Day	Time	Locations
Lecture	TUES	11:00-11:50	SC108 (Trent) UB 2034 (UOIT)
Lecture	FRIDAY	9:00-10:50	SC108 (Trent) UB 2034 (UOIT)
Seminar	FRIDAY	13:00-13:50	SC108 (Trent) UB 2034 (UOIT)

Course Evaluation:

Assignments: 30% (~bi-weekly, 4 or 5 in total)

Weekly Seminar Quizzes: 15% (~ weekly, 8 in total)

Mid-Term Exam: 20% (Friday, February 27, 09:00-10:50)

Final Exam: 35%

Roughly every two weeks, a problem set will be assigned with a well defined due date and time.

The seminar time will be used for two purposes: Primarily, a weekly quiz will be given at the beginning of most seminar sessions, and the remainder of the seminar will be devoted to taking up these topics. When needed, seminar time will be used for lecture make-up time.

By the class drop-date of March 5, 2014, it is expected that you will know approximately 35% of your final grade. This includes the results of your mid-term exam, and some quizzes and assignments.

Late Policy: Late assignments will be deducted 20% total grade, regardless of the reason for lateness, unless arranged in advance of the due-date with the instructor. Late assignments will no longer be accepted for grading after one week of lateness, resulting in a grade of zero.

Material delivery

Time Period or Date	Topic	Book Chapter
WEEK 1	Course overview, Maxwell's Equations and electromagnetic radiation	1,2,
WEEK 2	Formalisms: Wave, geometric, quantum	2,4
WEEK 3	Radiation and polarization state	14, 15, 23
WEEK 4 & 5	Controlling Polarization; Fresnel Eqns, dispersion, birefringence	23,25
WEEK 6 & 7	Superposition, speed of light, interference	5, 7
February 16-20	---Reading Week—NO CLASSES	
Feb 27, 09:00-10:50	Mid-Term	In Class (Trent) In Class (UOIT)
WEEK 8 & 9	Interferometry	8
WEEK 9 & 10	Coherence (temporal and spatial)	9
WEEK 10	Lasers	6
WEEK 11-12	Sources of light/ Absorption and Emission	6

This schedule is highly tentative and may change slightly to accommodate the needs of the class.

Learning Objectives: Upon successful completion of this course, the student should

- have an understanding of the frameworks of geometric-, wave-, and quantum- nature of light, as well as insight into when each framework is most conveniently used
- be able to convert various commonly-used and/or standardized units of measurements in optics; particularly for energy, frequency, and wavelength.
- be able to calculate reflection/transmission behaviour of light interacting with a dielectric interface, including the resulting polarization states
- Be able to describe the Lorentz Oscillator model, both for dielectrics and metals, and describe how such a model gives rise to index dispersion and absorption

- Be able to relate how anisotropy + dispersion can give rise to birefringence and dichroism
- Be able to analyze the polarization state of a beam of light; including that of single photons.
- Be able to describe four frameworks for setting and manipulating the polarization state of light
- Use ideas of birefringence to describe the operation of a waveplate (or “retarder”)
- Use ideas of birefringence and dielectric reflections to design/analyze various polarizing beam-splitting devices.
- be able to apply notions of superposition to predict the outcome from various wave interference applications
- have a rudimentary understanding of light coherence, the coherent properties of light from various sources, and the measurement of degrees of coherence.
- have general understanding of how the spatial interference of light leads to fringes, and be able to calculate the fringe visibility under specific interference conditions (such as the double slit, i.e.).
- have a working knowledge of the Fabry-Perot interferometer (and etalon), and the associated parameters (such as Finesse and FSR, i.e.) that characterize such interference-based devices.
- describe absorption and emission of light from a quantum mechanical perspective, and should be able to link the time-scale/rate of such processes with the spectroscopic linewidth of emitted radiation.
- have a rudimentary understanding of fundamental laser operation, including the necessary conditions for “lasing”.

University Policies

Please note that for both Trent and UOIT students, Trent University policies supersede those of UOIT for the purposes of this course. Thus it is all students’ responsibilities to become familiar with Trent University policies, scheduling, and calendar

Academic Integrity:

Academic dishonesty, which includes plagiarism and cheating, is an extremely serious academic offence and carries penalties varying from failure on an assignment to expulsion from the University. Definitions, penalties, and procedures for dealing with plagiarism and cheating are set out in Trent University’s *Academic Integrity Policy*. You have a responsibility to educate yourself – unfamiliarity with the policy is not an excuse. You are strongly encouraged to visit Trent’s Academic Integrity website to learn more: www.trentu.ca/academicintegrity.

Access to Instruction:

It is Trent University's intent to create an inclusive learning environment. If a student has a disability and/or health consideration and feels that he/she may need accommodations to succeed in this course, the student should contact the Student Accessibility Services Office (SAS), (BH Suite 132, 705-748-1281 or email accessibilityservices@trentu.ca). For Trent University - Oshawa Student Accessibility Services Office contact 905-435-5102 ext. 5024 or email nancyhempel@trentu.ca . Complete text can be found under Access to Instruction in the Academic Calendar.