TRENT UNIVERSITY

DEPARTMENT OF PHYSICS AND ASTRONOMY
TRENT UNIVERSITY

PHYS 4240H: Modern Optics
2017 WI

Peterborough

Instructor: Dr. Aaron Slepkov	**Trent Email:** aaronslepkov@trentu.ca	**Telephone:** x6216
Campus: Peterborough	**Office Location:** SC211	**Office Hours:** Wed: 14:00-15:00 Mon: 10:00-11:00

Academic Administrative Assistant: Gina Collins	**Email:** gcollins@trentu.ca
Office Location: SC327	**Telephone:** X7715

Course Description:

The goal of this course is 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)
Secondary text recommended reading: *Optics*, 4th edition, Eugene Hecht.

learningSystem/Blackboard: PHYS-4240H-A-W01-2017WI-PTBO Modern Optics. accessible via **www.learn.trentu.ca**

Course Format:

	Day	Time	Locations
Lecture	TUES.	16:00-16:50	SC317
Lecture	THURS.	12:00-13:50	
Seminar	WED.	13:00-13:50	

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.

Course Evaluation:
Assignments: 30% (~bi-weekly, 5 in total)
Weekly Seminar Quizzes: 15% (~ weekly, 8-9 in total)
Mid-Term Exam: 20% (Thursday, March 02, 12:00-13:50, in class)
Final Exam: 35%

Roughly every two weeks, a problem set will be assigned with a well defined due date and time. These "assignments" will provide opportunities for deeper engagement with lecture material and the course's learning outcomes. Some exam questions will be based on the material covered in the problem sets.

The two-hour midterm will test lecture material and skills/knowledge gained by doing the first two problem sets.

The three-hour exam will test lecture material and skills/knowledge gained throughout the course. It will be cumulative in nature, and will comprise approximately 35% pre-Midterm content and 65% post-midterm content.

By the class drop-date of March 10, 2017, it is expected that you will know approximately 30% 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 be accepted no later than the following lecture period, afterwards resulting in a grade of zero.

Week-by-week schedule:

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 20-26	---Reading Week—NO CLASSES	
March 02, 12:00-13:50	**Mid-Term**	**In Class**
WEEK 8 & 9	Interferometry	8
WEEK 9 & 10	Coherence (temporal and spatial)	9
WEEK 11-12	Sources of light/ Absorption and Emission	6

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

Learning Outcomes/Objectives/Goals/Expectations: I have developed the course to address several learning outcomes. By the end of the course a successful student should:

1. 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
2. be able to convert various commonly-used and/or standardized units of measurements in optics; particularly for energy, frequency, and wavelength.
3. be able to calculate reflection/transmission behaviour of light interacting with a dielectric interface, including the resulting polarization states
4. 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
5. be able to relate how anisotropy + dispersion can give rise to birefringence and dichroism
6. be able to analyze the polarization state of a beam of light; including that of single photons.
7. be able to describe four frameworks for setting and manipulating the polarization state of light
8. use ideas of birefringence to describe the operation of a waveplate (or "retarder")
9. use ideas of birefringence and dielectric reflections to design/analyze various polarizing beam-splitting devices.
10. be able to apply notions of superposition to predict the outcome from various wave interference applications
11. have a rudimentary understanding of light coherence, the coherent properties of light from various sources, and the measurement of degrees of coherence.
12. have general understanding of how the spatial interference of light leads to fringes, and be able to calculate the fringe visibility under specific intereference conditions (such as the double slit, i.e.).
13. 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.
14. 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.
15. have a rudimentary understanding of fundamental laser operation, including the necessary conditions for "lasing".

University Policies

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 documentation from a regulated health care practitioner and feels that he/she may need accommodations to succeed in a course, the student should contact the Student Accessibility Services Office (SAS) at the respective campus as soon as possible.