CONTACT INFORMATION:

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• Office Hours: Thursdays 4-5 pm Phy 353 TO BE CONFIRMED

• Contact preferences
  I encourage you to use the Discussion Forums on LEARN to discuss problems you have with the assignments or to ask questions about the course - if you are having problems, others likely are too. I will monitor the forums, normally at least once per day during the week and will respond to correct concepts, answer questions, etc. The ‘Notification’ feature of LEARN can be helpful for both instructors and students so that they can receive course alerts regarding new and changed Dropbox and assignment deadlines, grade updates and releases and news updates. Notification settings can be found at the following URL: https://uwaterloo.ca/learn-help/students/news

Feel free to contact Prof. Campbell by email, including PHYS 393 in the subject line. Emails will normally be responded to within 24-48 hours. Visit me in office hours or if needed make an appointment to see me.

Please make sure that your WatIAM ID is up to date with the email address that you use so that you receive notifications from me via Learn.

COURSE DESCRIPTION:

Optics is a very active field today and it is a field with many applications in physics, chemistry, engineering and the life sciences. There is a bright future for jobs and research for those trained in optics, both in the short term for imaging, visualization and displays, and biophotonics and in the longer term for quantum optics and telecommunications. Students at Waterloo have an opportunity to take an additional optics courses in 3rd or 4th year, PHYS 394 Light-Matter Interactions. Some concepts from Phys 256 will be BRIEFLY reviewed and then applied in this course.


• Course Prerequisite Requirements: PHYS 256/ECE 404; PHYS 364 or AMATH 353
  If you have failed a prerequisite or have withdrawn, you must inform Dr. Campbell.
**Course delivery:** Most lectures will be delivered using Powerpoint. Sample problems will be solved in class and extra tutorials if needed. There will be demonstrations in class as well as web based demonstrations. Lecture notes, additional review materials and web based demonstrations will be posted on LEARN. Assignments and solutions will be posted on LEARN. Some students will also make presentations in class on topics of their choice.

**LEARNING OBJECTIVES:**

- understand in more depth the wave nature of light
- understand in depth the meaning of equations describing light propagation and the interaction of light and matter described by refraction, dispersion and polarization changes
- be able to visualize and draw diagrams demonstrating the optical properties of light and materials
- understand the use of the Fourier transform to simplify optical descriptions and to produce desired optical effects
- better understand the design of optical instruments
- be able to solve more complex optical problems
- improve problem solving skills
- appreciate the breadth of applications of optics
- be able to read physics sources, extract key concepts and explain them
- improve written and oral scientific communication

**RESOURCES:**

- **Required Text:** OPTICS by E. Hecht, 4th or 5th edition. DELIVERY DATE FOR THE FIFTH EDITION IS JANUARY, 2016. This is a useful text for 3rd year courses and as a general optics reference. EDITIONS ORDERED FROM OVERSEAS OFTEN HAVE DIFFERENT PROBLEMS THAN IN THE NORTH AMERICAN EDITION
- **Suggested Reference Texts:**
  - Introduction to Fourier Optics by Goodman (a graduate level text)
  - The Fourier Transform & Its Applications by Ronald Bracewell
  - Linear Systems, Fourier Transforms, and Optics by Jack D. Gaskill
  - Learn materials See powerpoint notes, online demos, sample exams, problem solution sets, URL’s and other materials
- **Reserves:** The required text (Hecht 4th edition) and two suggested texts have been placed on reserve. A library copy of Hecht 5th edition has been requested.
- Relevant URL’s as given on Learn
- Blue goggle calculator, drawing instruments

**TOPICS:** **Planned Topics (Sections given are from Hecht 4th Edition):**

1. Review of Physical Optics from prerequisites- relevant notes posted as needed for the subsequent sections
   - Light as EM Waves, all EM waves described as a sum of sinusoids
   - EM Waves and Their Interaction with Matter
   - Linear polarisation
   - Refractive index, velocity and dispersion
   - Fresnel equations for normal incidence
-Addition of phasors, interference, intro to diffraction
-Interference from films
-Thin lenses
-Wavefronts, aberrations

2. Refractive index, velocity and dispersion
-Hecht 3.5.1 origin of dispersion see EM Waves and Their Interaction with Matter and Refractive Index and Dispersion from Phys 256
-Controlling Light: Dispersion, Group and Phase Velocities Hecht 7.2

3. Optics at an interface, thin films Hecht 9.4, 9.6, 9.7
-Light at Interfaces: Boundary Conditions for Refraction and Reflection
-Interference by Thin Films

4. Polarization Hecht Chapter 8
- linear, circular elliptical
- birefringence
Description of light- Jones vectors, Stokes vectors
- Interaction of light with matter- Jones matrices, Mueller matrices

5. Basics of Fourier Theory Hecht Section 7.3

6. Coherence and bandwidth Hecht 7.4.1, 9.2.1, 9.3.1, Chapter 12
- spatial and temporal

7. Fraunhofer Diffraction (perhaps Fresnel Diffraction) Hecht Chapter 10
-Adding Waves with Phasors

8. Fourier Optics Hecht Chapter 11
-Thin Lens Optics
- common Fourier transforms found in optics
- diffraction, dispersion and coherence
- lens as a Fourier transform
- Spatial distribution of optical information and spatial filtering Hecht 13.2
- applications of Fourier optics in optical imaging Hecht Chapter 13

ASSESSMENT:
MARKS:
○ Assignments 20%
○ 1 term test in class 15%
○ Class presentation OR written assignment 15%
○ Final Examination 50%
• **Final Mark:** best of: 20% assignments + 15% test + 15% presentation + 50% final OR 20% assignments + 15% presentation + 5% test + 60% final. HOWEVER, ANY STUDENT WITH LESS THAN 40% ON THE FINAL EXAM MAY FAIL THE COURSE.

• **MIDTERM** Tuesday, FEB 9TH IN CLASS RCH 209

• **See Problem Set due dates online.**

• **The course lecture plan and the schedule of due dates given above will be followed as closely as possible, but some changes may occur.**

• **Presentations or Papers:** See the separate description of the class presentation or paper on Learn. Students will choose a topic to present to the class from a suggested list or of their choosing in discussion with Prof Campbell. The presentations will be in the second half of term. The students should prepare powerpoint presentations and sample problems. 15% of the final mark will be based on the presentation, associated materials, answers to questions and questions asked of other presenters. Alternately, students may hand in a written assignment worth 15% on a topic from the suggested list or of their choosing in discussion with Prof. Campbell. Possible topics for oral and written assignments will be discussed early in the term. SEE NOTES ON PLAGARISM DETECTON SOFTWARE BELOW.

• **Midterm and final exam help sheets:** You will be allowed one 8.5 by 11.5 in single sided sheet of equations in the midterm and for the final examination. Maximum of 5 characters in any variable name. No other diagrams, words or units. You may have an additional single sided help sheet in any format for the final exam only. FAILURE TO FOLLOW THE EQUATION SHEET RULES MAY BE DEALT WITH UNDER POLICY 71 STUDENT DISCIPLINE AS AN UNAUTHORIZED EXAM AID. If the equation sheet has minor violations, a mark penalty of 5% will be assessed. If the sheet does not follow the guidelines and gives the student an unfair advantage, it may be taken from the student near the beginning of the exam.

• **You** will only be allowed to use a “Pink tie”, “blue google” or “yellow hardhat” calculator WITH AN APPROVED STICKER during the midterm and final exam. Blue google calculators are received by Science students in their orientation package. Those “pink tie” calculators purchased other than at the bookstore can get approved by seeing an advisor in MC 4023. These calculators are described here: http://math.uwaterloo.ca/math/current-undergraduates/regulations-and-procedures/calculator-regulation. Senior Science students may purchase ‘blue google’ calculators from the Book Store (the cost is under $20; supplies are limited).

• **Calculators without approved stickers will also be confiscated at the beginning of the exam AND THIS MAY BE DEALT WITH UNDER POLICY 71 STUDENT DISCIPLINE AS AN UNAUTHORIZED EXAM AID.**

• **Assignments:** There will be 6-7 weekly assignments during the term (1 to be forgiven), to be handed in online OR in the Phys 393 slot just outside room P211 by 4PM on the due date. **Alternating between assignments,** you will be asked to hand in corrected versions of questions that you get wrong on assignments and the midterm. Thus it’s important that you pick up copies of your marked assignments in lecture. **Handing in corrected versions will gain you back marks that you have lost on your assignments and will gain a small percentage increase on your midterm mark.** **PERFECT ASSIGNMENTS THE FIRST TIME WILL GAIN A SMALL BONUS %. 0.5% WILL BE DEDUCTED FOR EACH ASSIGNMENT OR MIDTERM NOT PICKED UP BY THE LAST DAY OF CLASSES**

  o Any changes in assignments to be given, assignment content, due dates or test dates will be discussed and announced in class and posted on the course webpage. However, the grading scheme will remain the same. Please set your alerts for Learn notifications as described above.
o Copies of solutions will be available on LEARN after you have handed in your corrections.
o These assignments should take a maximum of a few hours.
o CHECK LEARN FOR DUE DATES AND ANY CHANGES IN ASSIGNMENTS OR DUE DATES WHICH WILL ALSO BE DISCUSSED IN CLASS.
o Although students can learn a great deal by discussing the approach to problem assignments in group situations, it is not acceptable to copy each other's solutions nor is it acceptable to make a detailed verbal solution or a written solution to an assigned problem available to another student.
o THE ONLINE DROPBOX WILL CLOSE 24 HOURS AFTER THE DUE DATE. Please email me if you intend to hand in an assignment late. All late assignments must be handed in online (within 24 hours) or under Prof. Campbell’s office door (PHY 353). (The door to the corridor locks at 10pm and for the weekend). The physical dropbox in Physics will not be checked for late assignments.
o Late assignments will incur a penalty of 10% a day, including the day that the assignment is due, including 10% for the weekend. No assignments will be accepted after the solution set has been posted online.

- If you wish an EXTENSION ON AN ASSIGNMENT, provide reasons to Dr. Campbell in person or by email before the due date of the assignment.
- Dr. Campbell will retain assignments for pickup up to the final exam but beyond that date, assignments and midterms will be securely destroyed.
  - Deadline impacts of online learning environment service disruptions can be seen here: Service Interruptions in the Online Learning Environment: Guidelines for Instructors
  - Because of the potential for online interruptions, please download course materials well in advance of due dates, tests and exams.
- **Missed Exams, Term tests and Assignments:** A student who misses a term test, final exam, assignment, etc. and who provides a Verification of Illness (VIF) or other similar form (please see the information that will be needed) with a valid reason may be accommodated, at Prof. Campbell’s discretion, dependent on the severity of the situation and the student’s standing in the course. Notify Dr. Campbell, preferably before the due date. PROVIDE THE VIF AS SOON AS POSSIBLE. For legitimate reasons with adequate documentation, an alternative exam may be written during the Faculty of Science make up exam dates. BUT, FOR EXAMPLE, IF A STUDENT IS FAILING THE COURSE PRIOR TO MISSING THE FINAL EXAM OR PRESENTS WEAK DOCUMENTATION, THE STUDENT WILL BE ADVISED TO RETAKE THE EXAM THE NEXT TIME THAT THE COURSE IS OFFERED TO ALLOW NEEDED REMEDIAL WORK.
  - If the midterm or an assignment is missed for a valid reason, the grading system will normally be modified, placing more weight on the final exam.
  - Please feel free to discuss such situations or any other extraordinary circumstances with Dr. Campbell, preferably in advance of the assignment, term test or exam, but definitely within 48 hours unless you are too unwell to do so.
- **Reminder:** Only VIFs, issued from Waterloo’s Health Services (http://info.uwaterloo.ca/infoheal/_StudentMedicalClinic/VIF.html) are acceptable documentation when the service is available (https://uwaterloo.ca/health-services/about-health-services/hours). Students who are sick on a weekend, during off-hours, while out of town or receiving ongoing care from a family physician or specialist may have to provide valid and suitably informative VIFs from other health service providers. Information should include
  1) the date of the physician assessment
  2) the dates of illness
  3) the level of incapacitation,
4) • Basis of the assessment (i.e., physician’s examination or strictly the student’s description)
  o Students should bring their VIFs to the Science Undergraduate Office for verification and filing and then to Dr. Campbell.
• Important dates: PLEASE check appropriate uWaterloo websites (Important Dates on Learn for example) for details concerning various dates (e.g., final examination, drop deadlines)

PLAGRARISM SOFTWARE

PLAGIARISM DETECTION SOFTWARE (TURNITIN) WILL BE USED TO SCREEN THIS EXTRA ASSIGNMENT. THIS IS BEING DONE TO VERIFY THAT USE OF ALL MATERIAL AND SOURCES IN THIS ASSIGNMENT ARE DOCUMENTED. IN THE FIRST LECTURE OF THE TERM, DETAILS WILL BE PROVIDED ABOUT THE ARRANGEMENTS FOR THE USE OF TURNITIN IN THIS COURSE. STUDENTS WILL HAVE ACCESS TO TURNITIN BEFORE SUBMITTING THEIR ASSIGNMENTS IN ORDER TO CHECK THEY ARE EMPLOYING APPROPRIATE CITATION PRACTICES. IF STUDENTS DO NOT WANT TO HAVE THEIR ASSIGNMENT SCREENED BY TURNITIN, THEY WILL BE GIVEN THE OPTION OF A COMPLETE AN ANNOTATED BIBLIOGRAPHY IF THEY DO NOT WANT TO HAVE THEIR ASSIGNMENT SCREENED BY TURNITIN. PLEASE EMAIL ME IF YOU WISH TO DISCUSS FURTHER ALTERNATIVES.

COMMITMENT EXPECTATIONS

• You should be spending approximately 3 hours per week outside lectures working on the course for every hour that you attend lectures. Completing problem assignments should be a priority.
• I will monitor and comment on the online discussion of any difficulties with the problem assignments.

PRIVACY EXPECTATIONS:

• In order to protect their privacy, students may choose to hand in their assignments with their ID number as identifier or with a blank page with only their name on the front of the assignment.
  o In order to have your assignments and term test returned in person, please attend lectures. After the lecture at which an assignment is returned, Campbell will bring assignments to lectures and students can pick them up from a pile.
  o Tutorials are planned prior to the midterm and final exam. Please send emails to Dr. Campbell in advance of tutorials or classes describing concepts that you would like clarified or types of questions that are giving difficulty.
  o Dr. Campbell will not normally give one on one mini tutorials to students who miss lectures or tutorials. In that situation, students should photocopy the notes of a classmate or consult online materials.

ACADEMIC INTEGRITY:

• The Office of Academic Integrity provides relevant information for students, faculty and staff, including a fact sheet and an academic integrity tutorial.
• Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Students are expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for their actions. Completion of the Orientation to Academic Integrity Tutorial is encouraged and familiarity with Policy #71, (Student Discipline) is expected. Students who are unsure whether an action constitutes an offence, or need help in learning how to avoid offences (e.g., plagiarism, cheating) or understand ‘rules’ for
group work/collaboration should seek guidance from their course instructor, academic advisor, or the Associate Dean of Science for Undergraduate Studies. For information on typical Policy 71 penalties, students should check Guidelines for the Assessment of Penalties.

- Although students can learn a great deal by discussing the approach to problem assignments in group situations, it is not acceptable to copy each other’s solutions nor is it acceptable to make a detailed verbal solution or a written solution to an assigned problem available to another student.

- The Faculty of Arts has an excellent website on “Avoiding Academic Offences” or see Academic Integrity for Students.

- The following are also not acceptable:
  - Re-creating test questions and answers without the express permission of the course instructor
  - Obtaining, distributing or receiving unauthorized academic material without the express consent of the course instructor including assignments and solutions from previous course offerings
  - Sharing unauthorized course-related materials via hard-copy, email, social media or LEARN. The assignments and their solutions are the intellectual property of instructors and should not be posted without their permission.
  - Using LEARN email lists to sell or distribute unauthorized academic material.
  - In a presentation or paper, failing to adequately reference or quote material taken from sources (including figures).

- **Grievance:** Students, who believe that a decision affecting some aspect of their university life has been unfair or unreasonable, may have grounds for initiating a grievance. Students should read Policy #70, Student Petitions and Grievances, Section 4. When in doubt, students must contact the department’s/school’s administrative assistant who will provide further assistance.

- **Appeals:** A decision or penalty imposed under Policy 33 (Ethical Behavior), Policy #70 (Student Petitions and Grievances) or Policy #71 (Student Discipline) may be appealed, if there is a ground. Students, who believe they have a ground for an appeal, should refer to Policy #72 (Student Appeals).

**STUDENTS WITH DISABILITIES**

- **AccessAbility Services**, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If students require academic accommodations to lessen the impact of their disability, they should register with AccessAbility Services at the beginning of each academic term.

**COURSE RULES/CONSIDERATIONS:**

**Exam Period Policies**

- Exam Period: April 8th-23rd, 2016
- Students should start checking for posted exam dates toward the middle of February.
- Student travel plans are not considered acceptable grounds for granting an alternative examination time.
- More information about UW’s Final Examination policies is available here.

**Changes to Course Outlines**

- Revised course outlines will be posted/provided, if course details change (e.g., topics covered, emphasis on certain topics, etc.)
• Course elements that will **not** change are the:
  o Grading scheme
  o Course elements related to evaluation

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