CHM1482: Laser Spectroscopy and Photophysics

Course Syllabus, Winter 2020:

Instructors:
Prof. Mark W.B. Wilson, LM 241, mark.w.b.wilson@utoronto.ca
Prof. Gilbert C. Walker, LM 145, gilbert.walker@utoronto.ca
Note: E-mail is preferred. Only messages from UofT accounts will garner responses.

Classes: Mondays, 2–4pm (Lash Miller: LM128)

Office Hours: By Appointment

Website: The syllabus, assignments, and any course announcements will be posted on Quercus.
Log in with your UTORid at: `q.utoronto.ca`

Textbooks: There are no required textbooks for this course, and we will cover material from a range of sources. However, we highlight a few standard reference texts that are useful for more-thorough discussions, alternative perspectives, and extensions (well!-)beyond the course material.

Optics, 5th Ed. — Eugene Hecht (Reserve copy in Phys. library)
Lasers, 1st Ed. — Anthony E. Siegman (Reserve copy in Chem. library)
Optical Properties of Solids — Mark Fox (Reserve copy in Phys. library)
Quantum Optics — Mark Fox (Copies in Phys. library), (Fancy on-line access)
Nonlinear Optics, 3rd Ed. — Robert Boyd (Reserve copy in Phys. library)

Marking Scheme:

5 Assignments	45%
Research Highlight	15%
Final Exam	40%

Notes on assessment:

- The method of submission for each assignment will vary, and will be specified on the assignment sheet. For the three analytical problem sets (Tentatively due February 3rd, March 23rd, and April 3rd.), work must be submitted in hand-written hard-copy. Please indicate your name & student number clearly indicated on the first page. Submission of the Research Highlight assignment (tentatively due February 21st) and the two computational problem sets (tentatively due January 24th & March 9th) will be on-line via Quercus.

- The mark for a problem set submitted after the specified time and date will be reduced by 25% if handed in before the beginning of the first class after its due date, and by 50% if handed in afterwards. However, no marks will be awarded for assignments submitted after 2pm on April 8th.

- There are no make-ups available for the Final Exam, so students are advised to avoid schedule conflicts during the exam period. Students who miss the exam may contact the course instructors to discuss their situation. The potential impacts of unforeseen illness or injury will only be considered if the student presents a completed Verification of Student Illness or Injury Form, signed by an appropriate medical professional.

- Students with diverse learning styles and needs are welcome in this course—please discuss in-class accommodations and supports with the instructor. However, accommodations involving assessment will only be made on the advice of a University Disability Counsellor, who may require medical documentation. Accordingly, students are encouraged to register with Accessibility Services as soon as possible, to ensure that there is time to make arrangements.

(*Continued overleaf...*)

Academic Integrity:

Academic integrity is fundamental to learning and scholarship. Students are expected to be familiar with the University of Toronto's Code of Behaviour on Academic Matters—particularly Section B.i.1., which gives examples of student actions considered an offence against the Code. I also recommend consulting the 'Smart Strategies' regarding recording lectures, group work, and time management.

Summary of Course Aims:

CHM1482 is a tailored course for advanced students with an interest in Experimental Physical Chemistry here in the department. To support your broader research ambitions, we will jointly pursue three aims: 1) develop and demonstrate your knowledge of the fundamentals of optics & light-matter interactions 2) build, or extend, your familiarity with routine computational techniques 3) introduce you to selected topics in nonlinear, near-field, ultrafast, and quantum optics.

Syllabus:

1. *Intermediate classical optics* (∼4 two-hour lectures, Prof. Wilson)
    - Electromagnetic waves
    - Gaussian Optics
    - Polarization & Birefringence
    - Waves at interfaces
    - Diffraction & Fourier Optics
    - Interference
2. *Light-Matter Interactions* (∼6 two-hour lectures, Prof. Walker)
    - Radiative transitions in atoms: Classical description
    - Semi-classical treatment: Fermi's Golden Rule
    - Molecular photophysics: Electronic and Vibrational Spectroscopy
    - Nano-optics
    - Optics in Solids
3. *Introduction to Nonlinear Optics* (∼2 two-hour lectures, Prof. Wilson)
    - Series expansion of the polarizability: 2nd- & 3rd-order effects
    - Nonlinear pulse propagation
    - Applications of nonlinear optics
    - Pump-probe spectroscopies
4. *Introduction to Quantized Optics* (If time permits. . . , Prof. Wilson)
    - Photon Statistics, bunching/anti-bunching