

OPTI 380A: Intermediate Optics Lab I Syllabus

Instructor:

Professor Tom Milster, College of Optical Sciences, Office Rm 729

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Office Hours: drop-in or by appointment (I am usually in my office or lab)

Lab Schedule:

Lecture, Monday 1:00pm to 1:50pm, Room 408, Lab Room 450

Labs, Tues. 8:00am to 10:50am, 5:00pm to 7:50pm, Wed. 2:00pm-4:50pm

Thurs. 2:00pm to 4:50pm, 5:00pm to 7:50pm

Teaching Assistants:

Sarmad Albana, salbanna@optics.arizona.edu

Andrew Rasmussen, arasmussen@optics.arizona.edu

Course Objectives:

This lab course has been designed to closely follow OPTI 310, Physical Optics I. Some materials are related to OPTI 240 Semiconductor Physics and Lasers. It provides hands-on experience with most of the concepts taught in these courses. If you are majoring in Optics, then 380A is a required course. It is strongly recommended that these courses be taken concurrently to optimize your learning.

The main objectives for this lab are to understand the basics of physical optics, interference, diffraction, detectors, laser cavities, and the electro-optical properties of gas and semiconductor lasers. A variety of optical lab techniques will also be taught.

Upon successful completion of this course, each student should:

- be able to apply the optical principles discussed in OPTI 310 and OPTI 240.
- be able to clearly and accurately summarize and communicate experimental procedures and results.
- be proficient with data handling and analysis, using a computer.
- learn common optical methods and procedures that are routinely used in the optics industry.
- understand the safe and proper handling of basic optical equipment.

Gradings:

Pre Lab Questions	10%
Post Lab Questions	40%
Lecture Attendance and participation	10%
Lab Video Presentations	10%
Quiz (there will be 3 throughout the semester)	30%
TOTAL	100%

Lab Questions:

All pre lab questions must be submitted at the beginning of each laboratory session. They are designed to prepare you for the lab so that you can finish the lab on-time. You will receive zero credit for the pre lab questions, if you come to the lab without answering the pre lab questions. Post lab questions must be handed in class at the beginning of each lecture after the completion of the lab. Questions are graded 0-10 points. The average grade for each question is 7, corresponding to an A-. Correct answers often receive a 7 depending on the difficulty of the question. Grades of 9 or 10 are awarded for additional efforts, such as detailed explanations, data, plots, pictures or extra diagrams.

Late postlab writeups will be accepted up to a week after it was due, and will be graded at 75% off. All materials that are over a week late will receive zero credit.

Lab Notebook:

Students are highly recommended to keep detailed lab notebook.

A lab notebook can include the following sections:

- The **Equipment** used. Do this as a list, complete with a drawing for each setup.
- The **Procedure** that you followed. Do this as a single (short) paragraph for each experiment.
- The **Raw data** that you took. Do this as a numerical table or as written observation (depending on the particular experiment).
- A **Summary** of what actually happened, what you observed in the lab, and any problems you encountered.

Lab notebooks will not be collected or graded but can be used during a quiz.

Filmed Lab Summaries:

Each team must record a 3 minute video oral lab summary for each lab. At the end of your lab session, notify the TA, and he or she will film your lab summary with a video camera. Within the three minutes everyone in the team must speak at least once. You can use diagram and visual aids to facilitate your presentations. The camera stops promptly at three minutes. The professor and the two TAs will watch and grade the videos from all the teams at the end of every week. We will stop watching after three minutes. No repeat filming so you may want to practice first before actual filming. Videos can be shown during class for instruction purposes.

Quiz:

We plan to have 13 laboratories this semester. The quiz will be based on the lab that you have finished. Quiz 1 will be based on Lab 1-3. Quiz 2 will be based on Lab 4-7. Quiz 3 will be based on Lab 8-11. The quiz is designed to be 10-15 minutes long and you can use your lab notebook during the quiz. The quiz will include materials discussed in the lecture, the lab and can be taken directly from the prelab and postlab questions.

Textbook:

No required text. Supplements and additional materials are available at class website, which will be updated periodically during the semester:

<http://www.optics.arizona.edu/milster/380A%20Lab/Fall%202009/default.htm>.

Course policies:

It is *very important* to attend all lab recitation sessions, as what is discussed provides the theoretical and experimental background for the next lab. If you must be absent, it is your responsibility to obtain and review the information you missed. The students are encouraged to ask questions about the lab. Attendance for all of your scheduled lab sessions is mandatory. If you miss a lab session, it may not be made up unless you have a documented medical or family emergency. Quizzes may not be made up for any reason. The lab must be made up by noon on the Monday following the lab session that you missed.

Cell phones and pagers must be off or silent during lectures. During laboratories, cell phone conversations should take place in the hall outside the laboratory.

If you need to leave the room during lecture, please do so discretely, so that you won't disturb the professor and the students.

You are encouraged to work with each other as a team. You should not however copy each other's homework. This is considered cheating.

Safety

Safety is EXTREMELY important. We strongly urge you to always follow prescribed safety instructions- if you are unsure about anything, especially when dealing with high-intensity light sources (such as lasers), or with high-voltage power supplies (such as those found powering lasers or other laboratory equipment), ask someone who knows (namely the lab staff). You will receive training in how to deal with lasers and optics. However, some basic pointers to remember are listed below.

Laser Safety Requirements

1. Never look directly into a laser source, never point laser at anyone, even low-power lasers can blind!
2. Keep track of all stray light (and then block it).
3. Keep all high-intensity light beams at table-level.
4. Always keep your eyes a couple feet above table level. If you violate this exclusion zone, you will be asked to either leave the laboratory for the day, or you will be excluded from working on your project or laboratory exercise.
5. Wear safety glasses when appropriate. You MUST wear them when working with IR and UV laser light, as well as with mercury discharge lamps and strong light sources.
6. Keep your colleagues notified - tell them what you are doing so that they may protect themselves (and you). Always notify them if you turn on a laser or change the direction of the beam. Precautions also include closing the laboratory door, closing the window drapes (if appropriate), as well as turning on the laser warning light (light switch behind the chemical cabinet).
7. Always listen to the suggestions of the laboratory staff and your colleagues.
8. Keep your optics clean.
9. Practice good common sense.

10. All persons working with high-voltage should work in pairs. (see high voltage safety requirements below).
11. No drinking or eating is allowed in the lab. Hands must be washed before handling optics or electronics.
12. You may not work in the lab without supervision of an LA or a TA.
13. Cell phones (except for the lab staff) are not allowed to be turned on inside the Optics Lab.
14. Always inspect optical fiber carefully -- bare fiber can easily puncture your skin or your eye!

High Voltage Safety Requirements

1. **SHIELDING:** Live parts of all electrical equipment must be completely enclosed or otherwise guarded against accidental contact.
2. **INTERLOCKING:** Where continual maintenance or adjustments must be performed, enclosing shields must be provided with interlocks which will disconnect all power to conductors and short out capacitors when the shield is removed or opened.
3. **DISCONNECTS:** Provide an accessible, labeled main power disconnect switch.
4. **GROUNDING:** Ground all exposed non-current carrying parts. (Metallic optical table tops should be grounded to the nearest water pipe.)
5. **BONDING:** All grounded parts must be bonded to each other to keep them at the same grounded electrical potential.
6. **INSULATORS:** Adjustment mechanisms must be insulated from live electrical parts or be made of nonconductive material.
7. **SPACE:** A minimum of 30 inches width should be maintained on all working sides of equipment operating at 600 volts or less; 36 inches if over 600 volts.
8. **WORKING ALONE:** Working alone at any time is not allowed.
9. **CPR:** It is recommended that all persons working with lasers have training in cardiopulmonary resuscitation, available through the Safety Office, through the American Red Cross or through the American Heart Association.

Note: Violation of safety rules, if severe enough, may lead to automatic dismissal from the class. Such dismissible offenses include roughhousing, as well as moderate or serious injury due to careless action. Severe safety violations will lead to an automatic failing grade as well as possible action by the university as well as possible criminal liability. Some general rules follow:

For minor safety violations, you will receive a warning. After two warnings, you will be asked to leave the lab and come back on the next lab day (if it exists). If you are asked to leave due to an accumulation of minor safety violations (more than twice), you will receive an incomplete for the current lab, and therefore will not be able to receive a passing grade for the class.

Safety violations can be caused by a lack of sleep, alcohol, drug use (antihistamines, pain killers, alcohol, etc.), or emotional strife (daydreaming, family illness, etc.). Therefore, temporary dismissal from the lab is not meant to be punishment, but rather an opportunity for you to remedy what ails you. You may discuss your temporary dismissal with the lab staff **AFTER** the lab day. However, no excuses or arguments will be accepted at the time of dismissal - arguing

will only result in disciplinary measures. So far, we have never had to dismiss a student for safety violations... please don't be the first.

Additional Information

Academic Integrity

According to the Arizona Code of Academic Integrity (<http://deanofstudents.arizona.edu/academicintegrity>), "Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student's submitted work must be the student's own." Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. CO-AUTHORED WORK OF ANY KIND IS UNACCEPTABLE. Misappropriation of exams before or after they are given will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:

- * Reduction of grade
- * Failing grade
- * Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student's transcript re. academic integrity violation, etc.

Students with a Learning Disability

If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations.

(<http://drc.arizona.edu>).

References

- [1] Class notes are taken partially from those prepared by Mike Nofziger and Russell Chipman
- [2] E. Hecht, Optics, 4th ed., Pearson Education, (2001).
- [3] G. R. Fowles, Introduction to Modern Optics, Dover (1989).
- [4] K. D. Moller, Optics, Springer-Verlag (2002).
- [5] M. Born and E. Wolf, Principles of Optics, Cambridge University Press (1999).
- [6] M. V. Klein and T. E. Furtak, Optics, Wiley, John & Sons (1986).
- [7] Laser safety taken from <http://web.mit.edu/6.161/www/6161CourseSyllabusFA2005.pdf>
- [8] G. Joos, Theoretical Physics, 3rd ed., Dover (1986).
- [9] B.E.A. Saleh and M.C. Teich, Fundamentals of Photonics, Wiley (1991).
- [10] A. Yariv and P. Yeh, Optical Waves in Crystals, Wiley (1984).
- [11] A. E. Siegman, Lasers, University Sciences Books (1986).
- [12] J. W. Goodman, Introduction to Fourier Optics, 2nd ed., McGraw-Hill (1996).
- [13] G. P. Agrawal and N. K. Dutta, Long-wavelength Semiconductor Lasers, Van Nostrand Reinhold (1986).
- [14] Class notes from Opti505L, Spring 2009, See:
(http://www.optics.arizona.edu/milster/505%20Lecture/Spring%202009/opti_505_lec_Spring_2009.htm)

Intermediate Optics Lab I

OPTI 380A, Fall 2009

First day of classes Aug. 24, 2009

Week 1: 24 August 2009

Only Monday Lecture. No Labs.

Week 2: 31 August 2009

Lab 1: Semiconductor Light Sources I

Week 3: 7 September 2009

No Monday Lecture (Labor Day)

Lab 2: Semiconductor Light Sources II

Week 4: 14 September 2009

Lab 3: Detector Lab

Week 5: 21 September 2009

Lab 4: CDROM Player Lab, Quiz #1

Week 6: 28 September 2009

Lab 5: Wave Motion: Traveling Waves and Standing Waves

Week 7: 5 October 2009

Lab 6: Fresnel Reflection (s- and p-polarization, Brewster's angle)

Week 8: 12 October 2009

16 OCTOBER - LAST DAY TO DROP COURSE WITH A "W" (if passing)

Lab 7: Polarization, Wave Plates, Optical Isolator

Week 9: 19 October 2009

Lab 8: Interference: Division of Wavefront (Young's Double Slit, Lloyd's Mirror), Quiz #2

Week 10: 26 October 2009

Lab 9: Interference: Division of Amplitude (Michelson interferometer)

Week 11: 2 November 2009

Lab 10: Michelson Interferometer (applications)

Week 12: 9 November 2009

Reschedule Wednesday Labs (Veteran's Day)

Lab 11: Laser Cavities, Fabry Perot Filter (build a He-Ne laser)

Week 13: 16 November 2009

Lab 12: Fraunhofer Diffraction (single slit), Quiz #3

Week 14: 23 November 2009

No lab or lecture this week (Thanksgiving - Nov. 26-29)

Week 15: 30 November 2009

Lab 13: Fourier Transforms, Spatial Frequencies

Week 16: 7 December 2009

No Labs: Last day of classes Dec. 9