

# OPTI 380A: Intermediate Optics Lab I Syllabus (Fall 2024)

## (Revised on 08/26/2024)

Lecture: Monday 12:00-12:50PM, In Person

### **Instructor:**

- Prof. Hong Hua, College of Optical Sciences, Office Room 741 (west wing)
- Email: [hhua@optics.arizona.edu](mailto:hhua@optics.arizona.edu)
- Phone: 520-626-8703
- Office hour (in person or via zoom): Monday 11:00-11:50AM or by appointment. I will also be available for Zoom chats at this time. You can contact me by email to set up a Zoom chat.
- <https://arizona.zoom.us/j/86859037939> (passcode: 380A)

### **Co-Instructor:**

- Prof. Tom Milster, College of Optical Sciences, Office Room 729 (west wing)
- Email: [milster@optics.arizona.edu](mailto:milster@optics.arizona.edu)
- Phone: 520-626-8280

### **Teaching Assistants:**

- Lam Nguyen (TA): [ltn99@arizona.edu](mailto:ltn99@arizona.edu)
- Office hour: Tuesday 4:50-6:00PM in Lab 450

### **Lab Schedule (Room 450):**

Session 1:	Tuesday	2:00pm – 4:50pm
Session 2:	Wednesday	5:00pm – 7:50pm
Session 3:	Thursday	2:00pm – 4:50pm

### **Video Lab Lectures (on-line, mandatory):**

A series of lab lectures are posted on Panopto. **It is mandatory that you view the video before trying to perform the lab.** A schedule is listed at the end of this syllabus. The mini quizzes, as described below, are based on the videos each week. Note that the videos may contain some outdated information, with respect to the lab number and exact layout of the experiments. However, the technical content of the videos is accurate. The lab recitation section on Monday at noon each week will cover changes and undated information.

### **Monday Recitation Sessions (noon-12:50pm, Room 410):**

The Monday recitations in classroom 410 will briefly review the lab of the week and cover changes from the recorded video lectures. Recitation sessions are usually very short, and they will not take the full hour in most cases.

### **Course Objectives:**

This lab course has been designed to closely follow OPTI 210, Physical Optics. Some materials are related to OPTI 341 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.

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 210 and OPTI 341.
- 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.

### **Grading:**

I do not grade on a curve. Grades are assigned by: 100% – 90% = A, 89% – 80% = B, 79% – 70% = C, 69% – 60% = D, Below 60% = E. Points are rounded to the nearest whole %.

On-Line Mini Quizzes (11 throughout semester)	22 %
Lab reports (6 written and 5 video)	44 %
Final report	34 %
<b>TOTAL</b>	<b>100 %</b>

#### ***1. On-Line Mini Quizzes:***

On-Line Mini quizzes are accessed through D2L. They are based on the instructional video that has been recorded for each lab and are listed in Panopto. Each student has 15 minutes to complete a mini-quiz. It contains four True/False and/or Multiple Choice questions. Questions are randomized, so it is unlikely that any two quizzes are the same. You have three attempts, each 15 minutes in length, to complete each mini-quiz, and the highest score out of three attempts will be recorded. The mini-quiz for each lab **must be completed before Friday at 5pm as listed in the schedule at the end of this syllabus.**

#### ***2. Written Lab Reports (Labs 1-6):***

Written lab reports have three components, which are the summary (60%), answers to questions (30%) and individual conclusions and contributions (10%). The summary is in the form of a standard lab report. Answers to questions are submitted separately. The third component, individual conclusions and contributions, is a short report submitted separately by each student. All components are due on midnight one week after your lab session. For example, Tuesday sessions have their lab reports due on midnight the following Tuesday. **LATE COMPONENTS RECEIVE ZERO CREDIT. YOU MUST SUBMIT YOUR COMPONENTS IN THE APPROPRIATE D2L DROPBOX TO RECEIVE CREDIT.**

##### ***2.1 First component of written lab reports: Group Summary (60%)***

The first component is a summary of each experiment with a five-page maximum, which contains the following:

- 1) Lab number and title;
- 2) Names of group members;
- 3) Outline of experiments (short section simply listing experiment titles); and
- 4) For each experiment,
  - a) Explain the purpose or hypothesis you are testing (15%)
  - b) Show the setup (5%)
  - c) State the expected outcome (5%)
  - c) Explain how measurements are made (10%)
  - d) Show data and results (15%)
  - e) Draw conclusions by comparing your results with the expected outcome (10%)
  - f) Supplemental video files are encouraged, but they should NOT be loaded onto D2L. You can put them on a vehicle like YouTube and display a hotlink in your report. However, your grade is based on the written report.

The first component is submitted to D2L as a summary report. A separate section on D2L is established for this purpose. Be sure to identify last names of the group members (for group reports), lab TA and lab number in the filename loaded into the D2L Dropbox. The first component is 60% of the total 100% for the lab report.

**Note that Lab 1 requires each student to write a complete written report and answers to questions.** Individual lab instructions will state whether the lab is an individual lab or a group lab. If the lab requires a group report, only one member of your group should submit the report for that week. For example, Lab 2 is a group lab on linear polarization.

### **2.2 Second component of written lab reports: Answers to Questions (30%)**

The second component of the written lab report is a listing of answers to questions that are specified in the lab handout. A separate section on D2L is established for submitting your questions. Be sure to identify last names of the group members, lab TA and lab number in the filename loaded into the D2L Dropbox. Only one member of your group should submit the answers to questions each week if it is a group lab. The second component is 30% (6%/question) of the total 100% for the lab report.

### **2.3 Third component of written lab reports: Individual Conclusions and Contributions (10%)**

The third component (10%) of the written report is the individual conclusion and contribution. A separate individual contribution statement must be submitted by each student, whether the lab is an individual lab or a group lab. Duplication of this section between students is strongly discouraged and will suffer loss of credit. The report is submitted to D2L under the “Individual Conclusions and Contributions” section. Be sure to identify the lab number in the filename loaded into the D2L folder. Label the lab number and your section letter in the filename of your individual report. This report contains two paragraphs, which **MUST NOT EXCEED 200 words** total. One figure, photograph or image may be included, if desired. The paragraphs contain:

- *Paragraph 1:* Overall original conclusions drawn from the lab (5%). Don't just repeat group conclusions from the summary. I want to know what YOU learned and/or enjoyed that was significant *beyond* conclusions in the written report. Good: "I found it interesting that the pattern of the LED as it reached stopping potential outlined concentric circles and arrows. I wonder why this pattern is present. Is it functionally related to the circuitry of the device?"
- *Paragraph 2:* Your individual contribution for the lab (5%). What did you do in the setup, measurement and analysis. Try to be creative and think beyond the posted list of instructions. Additional measurements to complete your understanding are encouraged. Bad: "I used my cell phone to take pictures", with no other comment.

### **3. Video Lab Reports (Labs 7-11):**

Like with the written lab reports from labs 1-6, the video labs contain three components, which **are a group video, answers to questions and individual conclusions and contributions**. Note: Labs 7-11 are all *group labs*. The first component is a video, as explained below. Answers to questions are submitted separately and are also prepared as a group report. The third component, individual conclusions and contributions, is a short report submitted separately by each student. **The video is due on YouTube 48 hours after the end of your lab session.** One group member must email the instructor and TAs with the YouTube link within the 48-hour window. Answers to questions and individual reports are due on midnight one week after your lab session. For example, Tuesday sessions have their second and third components due on midnight the following Tuesday. **LATE COMPONENTS RECEIVE ZERO CREDIT. YOU MUST SUBMIT YOUR COMPONENTS IN THE APPROPRIATE D2L FOLDER TO RECEIVE CREDIT.**

#### **3.1 First component of video lab reports: Group Video (60%)**

Each team must record a 3-minute video oral lab summary for each lab. Use your cell-phone or laptop/tablet camera to record scenes related to your experiments. Material presented in the final video can be recorded during lab time or at home with Home Kit tasks. Within the three minutes, everyone in the team must speak at least once. The first 10 to 15 seconds of the video must show the team members, with introductions, the title of the lab, the course name, and your TA's name. You can use diagrams and visual aids to facilitate your presentations, but they must be produced and recorded during lab time. It is also good to show the experimental setup and components. Explain the theory, as time allows. The videos are graded from all the teams at the end of every week. We will stop watching after three minutes. Videos can be shown during class for instruction purposes. 60% out of the 100% total for each video lab report comes from the video. **UPLOAD YOUR VIDEOS TO YOUTUBE AND SEND THE LINK VIA EMAIL TO THE TAs AND THE INSTRUCTOR WITHIN 48HRS AFTER THE END OF YOUR LAB SESSION. OTHERWISE, YOUR VIDEO WILL NOT BE GRADED.**

Video Grading Rubric: Total 60%.

#### General (10%)

- Title/introduction (see above), everybody speaks,
- follow the lab procedure, know all the parts of the lab,
- result & diagram organization.

#### Completeness (20%)

- Finish the presentation within 3min(overtime material won't be graded),

- cover all parts of the lab,
- present the concepts/layout/theory of each experiment,
- state your results in a clear manner. Include all necessary data.

#### Accuracy (20%)

- Present your data in an understandable way (with correct units)
- Getting incorrect or no results is acceptable, but recognize and explain any unreasonable results.

#### Style (10%)

- Clear presentation, readable text on graphics.
- Smooth transition between segments.
- Originality.

### **3.2 *Second component of video lab reports: Answers to Questions (30%)***

(See this section under the written reports description.)

### **3.3 *Third component of video lab reports: Individual Conclusions and Contributions (10%)***

(See this section under the written reports description.)

## **4. *Final Project Lab & Report***

The last four and half weeks of the semester (Weeks 12 through 16) are reserved for Final Projects. These projects are *group efforts*, similar to individual labs. You and your lab partners will design and carry out an experiment based on the general topic of Physical Optics. The focus of this lab will be presented later in the semester.

As a group, you will submit a final project report to D2L that follows the first-component format of the Written Lab Reports listed above. In addition to the criteria listed there, you will be graded on your creativity and original thinking. The presentations will be pre-taped and can be edited. Videos **MUST NOT EXCEED 4 MIN IN LENGTH**. Additional details concerning the final presentation videos will be posted later in the semester. 90% out of the total final report grade comes from the video and written reports. *The remaining 10% is from the individual report, which are also due with the group report.*

Laboratory items for your experiments can be obtained from lab stock and home kits on a first-come, first-served basis. You will sign any parts out on a sign-up sheet, and you will be responsible for returning all borrowed parts and equipment in order to pass the class. Bring a labeled box with a lid that can be closed to hold your parts, if you do an in-lab project. You will put parts in the box when not actively working on the project. The instructors and TA will not take any responsibility for lost, stolen or damaged personal materials. It is encouraged and expected to have students work extra hours outside the reserved lab hours on their final projects. A generous amount of open lab time will be available for this purpose, and it is expected that a significant portion of your work will be done at home.

As with Labs 1-11, *individual conclusions and contributions must be submitted to D2L and due with the group written report.* Students should identify in their individual reports their

contributions to the project, as well as their original individual conclusions. Extrapolations from group results are encouraged. Grades from these individual reports constitute the remaining 10pts of the final project grade.

FINAL WRITTEN REPORTS AND VIDEOS ARE DUE DEC 13th by 5pm. Turn in videos on YouTube, as with Labs 7-11. Write a short summary of the video with the complete title in the text that accompanies the video on YouTube. I would encourage you to make these videos PUBLIC access. You will be putting a lot of work into it, and THESE VIDEOS ARE GREAT OUTREACH AND RECRUITING RESOURCES FOR OUR COLLEGE.

Detailed grading of the Final Project Lab (100% total) will consist of:

- 1.) 50% Group Written Report submitted to D2L
- 2.) 40% Group Video
- 3.) 10% Individual written report to D2L

Final Project Cleanup:

- 1.) Each lab group must clean up their portion of the lab that was used for the final project. You will complete a "Cleanup Form" that must be signed by your TA before your final project is graded.
- 2.) If you borrowed any equipment from the lab, your inventory sheet must be approved by Hillary Mathis (Teaching Lab Coordinator) and the equipment must be put away properly.
- 3.) You MUST submit your signed inventory sheet and cleanup form to D2L by 12/7. Your final project WILL NOT BE GRADED if the inventory sheet or cleanup form is not submitted on D2L. There will be a Dropbox folder on D2L specifically for this purpose.

In previous years, I was disappointed to see several quality optical components, including lenses and wave plates, lying openly on the tables in the Junior Lab. Please take good care of these components! They are very expensive and can be used for many years if cared for properly.

### **Lab Notebook:**

Students are highly recommended to keep a detailed lab notebook, but it will not be graded. Personally, I like OneNote for this purpose.

### **Textbook:**

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

D2L website: [www.d2l.arizona.edu](http://www.d2l.arizona.edu)

### **Course Policies:**

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. The lab must be made up by noon on the Monday following the lab session that you missed. Please contact your TA for possibly switching lab groups the week you are absent.

During laboratories, cell phone conversations should take place in the hall outside the laboratory.  
NO FOOD OR DRINK IS ALLOWED IN THE LAB.

## **Safety**

Please see: [UArizona's Administrative Directive](#) regarding face coverings while in the laboratory.

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.

### ***1. Laser Safety Requirements***

- Never look directly into a laser source, never point laser at anyone, even low-power lasers can blind!
- Keep track of all stray light (and then block it).
- Keep all high-intensity light beams at table-level.
- 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.
- 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.
- 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).
- Always listen to the suggestions of the laboratory staff and your colleagues.
- Keep your optics clean.
- Practice good common sense.
- All persons working with high-voltage should work in pairs. (see high voltage safety requirements below).
- No drinking or eating is allowed in the lab. Hands must be washed before handling optics or electronics.
- You may not work in the lab without supervision of an LA or a TA.
- Cell phones (except for the lab staff) are not allowed to be turned on inside the Optics Lab.
- Always inspect optical fiber carefully -- bare fiber can easily puncture your skin or your eye!

### ***2. High Voltage Safety Requirements***

- **SHIELDING:** Live parts of all electrical equipment must be completely enclosed or otherwise guarded against accidental contact.

- **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.
- **DISCONNECTS:** Provide an accessible, labeled main power disconnect switch.
- **GROUNDING:** Ground all exposed non-current carrying parts. (Metallic optical table tops should be grounded to the nearest water pipe.)
- **BONDING:** All grounded parts must be bonded to each other to keep them at the same grounded electrical potential.
- **INSULATORS:** Adjustment mechanisms must be insulated from live electrical parts or be made of nonconductive material.
- **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.
- **WORKING ALONE:** Working alone at any time is not allowed.
- **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>).

## Intermediate Optics Lab I Schedule OPTI 380A, Fall 2024

First day of classes Aug. 26, 2024

Lab, Lecture & Mini-Quiz Schedule				
	Lab Topics	Panopto Video	Lecture (Monday)	Mini Quiz Due (5PM, Friday)
Week 1 (Lab 1)	Wave motion, refraction, and focusing	opti380a_r1_Wave motion	08/26, Intro/Lab 1	08/30, MQ 1
Week 2 (Lab 2)	Linear polarization and Fresnel reflection	opti380a_r2 - Linear Polarization	09/02, No Lecture (Holiday)	09/06, MQ 2
Week 3 (Lab 3)	Polarization, wave plates and optical isolator	opti380a_r3 - Waveplates and Stokes Vectors	09/09, Lecture 3	09/13, MQ 3
Week 4 (Lab 4)	Optical data storage (CD/DVD Player Lab)	ODS	09/16, Lecture 4	09/20, MQ 4
Week 5 (Lab 5)	Division of Wavefront (Young's Double Slit, Lloyd's Mirror)	opti380a_r5 - Division of Wavefront Interferometers	09/23, Lecture 5	09/27, MQ 5
Week 6 (Lab 6)	Interference: Division of Amplitude (Michelson Interferometer)	<ul style="list-style-type: none"> <li>• opti380a_r6 - Michelson Interferometer - Part 1</li> <li>• opti380a_r6a - Michelson Interferometer - Part 2</li> </ul>	09/30, Lecture 6	10/4, MQ 6
Week 7 (Lab 7)	Michelson interferometer applications	opti380a_r7 - Michelson Applications	10/07, Lecture 7	10/11, MQ 7
Week 8 (Lab 8)	Laser Cavities, Fabry Perot Filter	opti380a_r10 - LASER	10/14, Lecture 8	10/18, MQ 8
Week 9 (Lab 9)	Diffraction	opti380a_r11 - Diffraction	10/21, Lecture 9	10/25, MQ 9
Week 10 (Lab 10)	Semiconductor light sources	opti380a_semiconductor light sources	10/28, Lecture 10	11/01, MQ 10
Week 11 (Lab 11)	Detectors	opti380a_detectors	11/04, Lecture 11	11/08, MQ11
Week 12	Project Part A		11/11, No Lecture (Holiday)	
Week 13	Project Part B		11/18	
Week 14	Project Part C		11/25	
Week 15	Project Part D		12/02	
Week 16	Project Wrap Up		12/09	
Week 17				

**Week 14: 25 November**

Labs will be open for those wishing to work on Project Labs. Schedule TBD.  
Thanksgiving recess Nov 28-Nov 29.

**Week 16: 9 December**

**FINAL REPORTS AND VIDEOS DUE BY 5PM DEC 13. TURN IN VIDEOS on YouTube.**

*No Labs: Last day of classes Dec. 11th*