



PASADENA CITY COLLEGE

Laser Technology Program

LASR245: *Quality Assurance of Precision Optics*, the Syllabus

Welcome to the first Laser Technology course offered at Pasadena City College! This is actually the third in the Laser Technology sequence, but there are no prerequisites, so I welcome both new and experienced students. I am your Laser Technology professor, **Dr. Brian Monacelli**, and I encourage frequent communication via email. I can be reached at BrianMonacelli@Protonmail.com anytime. (I check this much more frequently than BMonacelli@Pasadena.edu)

This course addresses the basics of specification, manufacturing, and assessment of precision optics. It presents an introduction to quality assurance (QA) practices required to identify, inspect, and measure optical components. Materials and tools found in an industrial optics fabrication and inspection shop are used in lecture demonstrations and laboratory experiments. Students will gain hands-on experience with these industrial materials and QA tools in the laboratory.

Classes will be held in real time via Zoom during the **Fall 2020** semester, on **Fridays from 16:00 to 20:00**. The textbook is **OP-TEC's *Quality Assurance of Precision Optics*, NSF/UCF, 2013**. There are no prerequisites, but recommended preparation is LASR215 *Light + Lasers* and LASR230 *Optical Devices*.

Grading is based on **150 points** (the denominator): **A:** >90%, **B:** >80%, **C:** >70%, **D:** >60%, **F:** ≤60%

Lab reports earn 5 points each, **midterm and final exams** earn 50 points each, and one **oral presentation** earns 20 points. *There will not be traditional homework in this class*, but reading and studying the “Problem Exercises and Questions” in the text will help you learn the material.

Lab reports are the core of this course. They are expected to be industry-quality documentation including analysis and discussion of the data observed or measured during the laboratory activity. Lab reports are due before the following lecture, and late lab reports are only allowed with advance arrangement. Please submit lab reports only **in PDF format** by emailing them to BrianMonacelli@Protonmail.com. Name the files of electronic reports as follows, where “xx” is the two-digit lab number, in ALLCAPS: **LASR245LABxxLASTNAME.PDF**

One individual, **5-minute oral presentation** will be given during the second half of the course. This presentation topic will be your choice, either an industry survey or the measurements of a previous laboratory report. Presentations shall be written for a technical audience, including a discussion of the lab's purpose, the data-acquisition techniques, a comparison of measurements to theoretical expectations, a discussion of required research, conclusions, and recommendations for improvement.

The **midterm exam** will be given in October 2020.

The comprehensive **final exam** must be given by 11 December 2020.



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Course Content Outline

1. Fabrication of Precision Optics
 - A. Precision Optical Materials (versus common materials that interact with light)
 - B. Fabrication of Transmissive Optical Materials
 - i. Glass Optical Substrates
 - ii. Flaws within Transmissive Optics
 - iii. Processing the External Surfaces of Transmissive Optics
 - C. Fabrication of Reflective Optical Materials
 - i. Glass Optical Substrates
 - ii. Metal Optical Substrates
 - iii. Ceramic Optical Substrates
 - D. Plastic Optical Substrates
 - E. Optical Coatings
 - i. Optical Coating Deposition
 - ii. Coating Chambers and Fixtures
 - iii. Coating Flaws
 - F. Optical Components:
 - i. Lenses and Mirrors
 - ii. filters, polarizers, waveplates
 - iii. Diffractive Optical Elements
 - G. Absorptive Media
 - H. Optical Assemblies
2. Characterization of Precision Optical Components
 - A. Quality Assurance Terms and Techniques Used for Evaluation of Precision Optics
 - i. General Technical Measurements
 - ii. Optical Measurements
 - iii. Measurement Tools
 - B. Dimensional Parameters of Precision Optics
 - i. Lengths
 - ii. Angles
 - iii. Curves
 - C. Optical Material Properties
 - i. Fundamental Glass Parameters: Refraction and Dispersion
 - ii. Measurement of Glass Parameters
 - iii. Radiometric Energy Transfer when Light Interacts with a Material



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3. Specifications and Drawings for Precision Optics
 - A. Interpreting Drawings
 - B. Important Standards and Documents for Optics and Photonics
 - C. ISO 10110 Summary
 - i. ISO 10110 Part 1: General Specifications
 - ii. ISO 10110 Part 5: Surface Form Tolerances
 - iii. ISO 10110 Part 6: Centering Tolerances
 - iv. ISO 10110 Part 7: Surface Imperfection Tolerances
 - v. ISO 10110 Part 8: Surface Texture
 - vi. ISO 10110 Part 9: Surface Treatment and Coating
 - vii. ISO 10110 Part 10: Table Representing Data of a Lens Element
 - viii. ISO 10110 Part 11: Specifications for Non-toleranced Data
 - ix. ISO 10110 Part 12: Aspheric Surfaces
 - x. ISO 10110 Part 14: Wavefront Deformation Tolerance
 - xi. ISO 10110 Part 17: Laser Irradiation Damage Threshold
 - xii. ISO 10110 Part 18: Stress Birefringence, Bubbles and Inclusions, Homogeneity, and Striae
 - xiii. ISO 10110 Part 19: General Description of Surfaces and Components
 - D. Environmental, Thermal, and Other Important Considerations for Optical Elements and Coatings
 - E. Mounting Precision Optics into Optical Assemblies

Laboratory Topics

Topics shown in bold will be conducted ~~at the facilities of~~ in partnership with our industrial affiliate **PRECISION OPTICAL in Costa Mesa, California.**

- 1) Measure the dispersion and refractive index of optical materials
- 2) Assess internal defects found within common optics and clear, non-optical parts
- 3) Investigate differences in image quality, and durability between glass and plastic optics
- 4) Document processing steps required to cut and shape precision optics**
- 5) Measure the properties of diffraction gratings, including efficiency and diffraction angles
- 6) Document processing steps required to grind and polish precision optics**
- 7) Employ fundamental optical shop tools, for example calipers, height gauges, gauge blocks
- 8) Evaluate precision optics via polarimetry to observe stress birefringence
- 9) Learn how to assess which side of an optical element is coated
- 10) Assess cleanliness, imperfections, and surface damage to optical substrates and coatings
- 11) Document the cleaning and inspection of a precision optical element to an ISO 10110 print**
- 12) Create drawings of optical elements with specifications detailed to the ISO 10110 Standard



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Student Learning Outcomes (SLOs)

1. Explore elements of precision optical material and fabrication processes that produce them.
2. Conduct routine assessments of optical materials in the laboratory.
3. Formulate plans to evaluate basic optical properties of different optical elements using standard optical test equipment and quality assurance principles.
4. Use industry standards and schematics to design and construct elements of optical systems.

Additional Topics

- **Office hours:** via Zoom from 15:00 to 15:30 each Friday, and after lecture ends for 30 minutes. Come prepared with questions.
- **Safety:** If we are allowed to meet in person, **safe laboratory practices are essential**. Any student demonstrating unsafe laboratory practices will be asked to leave the class, and an incident report will be submitted.
- **Attendance:** Attend every lecture ~~and laboratory~~ to document your work in a bound physical notebook and/or an electronic journal—labs are held weekly because this is a hands-on course. You will likely use these experiences in your current or future job, so ensure your documentation is written so that it will be comprehensible in the future. If you cannot attend a ~~laboratory~~ lecture, it may be made up only if arrangements were made in advance by emailing the instructor. If advance arrangements were not made, a 0% grade is earned for that lab.
- **Withdrawing:** Last day to drop with "W" grade is specified on the Pasadena.edu website. *Please discuss dropping the course with the instructor prior to dropping the course.*
- **College Policies:** PCC has several policies in place to foster a positive and inclusive learning environment. These include the Academic Integrity & Student Conduct Policy (<http://www.boarddocs.com/ca/pasadena/Board.nsf/goto?open&id=AM7PCG63E805>), Course Attendance, Adds, Drops, and Withdrawal Policy (<http://www.boarddocs.com/ca/pasadena/Board.nsf/goto?open&id=AM7P85635300>), and the Complaints, Grievances, and Student Due Process Policy (<http://www.boarddocs.com/ca/pasadena/Board.nsf/goto?open&id=AM7QWV6B5A50>).
- **Academic Integrity:** Your thoughts and ideas are important. In order to protect your words and others' words, we have rules about plagiarism. Students are required to cite the use of materials written by others in all communication for courses. Plagiarism is the presentation of someone else's ideas or work as one's own, including using ideas, words, or phrases without proper attribution. Please review the "Student Conduct Code" in the General Catalog (<https://pasadena.edu/academics/catalog-schedule-calendar.php#catalog>).
- **Discrimination & Complaints:** PCC is committed to the fair and equitable treatment of all students. There are policies in place to protect all students from discrimination. These policies include non-discrimination and sexual harassment policies which can be found at Discrimination Complaints (<https://pasadena.edu/student-services/grievances.php#discrimination>)



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Student Resources

If you have a disability and believe you may need an accommodation such as materials in an alternate format, sign language interpreting/real-time captioning, access to assistive technology and/or test accommodations, per the Americans with Disabilities Act or Section 504 of the Rehabilitation Act please contact Disabled Students Programs and Services at 626-585-7127 as soon as possible and please feel free to discuss your needs with me in private.

PCC offers many academic and personal support services to help you be more successful, including Counseling, Tutoring, Library, Financial Aid, Health Services and more. Please explore these available free services:

- **Academic Support & Counseling:** Visit our student success centers for the support you need. Counselors can help you with educational planning, transferring to a university, academic and personal challenges, and more. Be sure to visit a counselor to complete your comprehensive student education plan. This is needed to maintain priority registration and financial aid.
- **Financial Aid:** The Office of Financial Aid and their knowledgeable advisers are here to make your education affordable.
- **Health & Well-Being Services:** PCC offers a variety of free and low-cost services to help you maintain your physical and emotional well-being. Please contact Student Health Services and Personal Counseling when you need support.
- **Website:** View all Student Services at <https://pasadena.edu/current-students/index.php>