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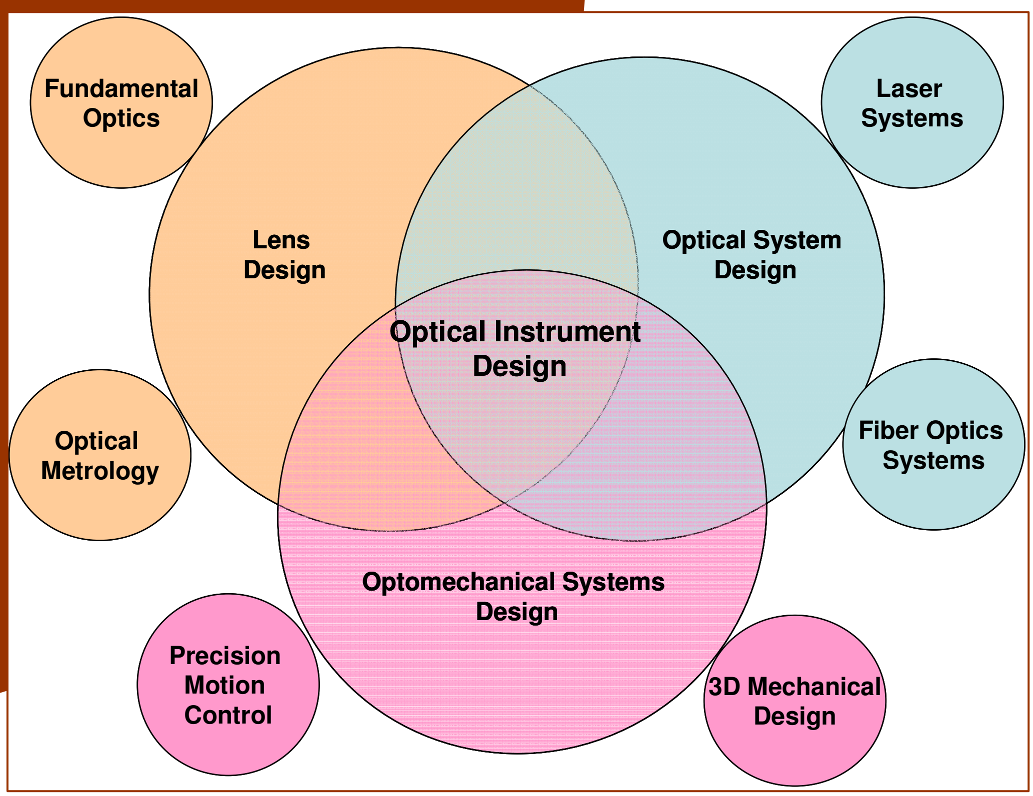
# Optical Engineering Certificate Program

# Optical Instrument Design Certificate Program

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**UC Irvine Extension**

# Optical Engineering Certificate Programs

## PROGRAM DESCRIPTION

These new optical engineering and instrument design programs were established to meet the growing needs of the local optics industry and are filling a need to have trained engineers and designers skilled in the art of design and associated analysis of lenses, advanced optical systems and optomechanical systems. Traditionally and currently, there are many firms who have very good and experienced lens and optical systems designers and engineers and also mechanical designers and engineers; however, many times there seems to be a gap between the two groups. These programs aim to fill that gap by training students on both sides of the equation. Student prequalification for entrance into this program includes a solid fundamental knowledge of optics. For students who have not completed this type of education the program also offers introductory optics fundamentals, lasers, fiber optics, mechanical, metrology and motion control short courses.

The **Optical Engineering Certificate Program** is centered on the optical instrument design courses which start with introductory and advanced hands-on lens design courses which provide three basic skills: *manual, design code,* and *design philosophy***.** Manual skills include first and third order calculations by hand, *design code* skills include prescription entry, optimization and design analysis and *design philosophy* is about selecting a starting point and developing a plan of the design. The next two courses cover advanced optical systems design and analysis beginning with modeling coordinate breaks, multi-configurations, systems analysis and tolerancing and athermalization. The last two courses form the basis for the **Optical Instrument Design Certificate Program** and cover optomechanical systems design and bridge the gap between the optical and the mechanical systems. The students learn how to evolve their optical design into the mechanical design environment which includes material selection, tolerancing, vibration isolation, the assembly and alignment strategies; including alignment jigs and fixtures design. This certificate program is completed during a final project period where the students showcase their learning experience in a project chosen by the student and approved by a program advisor.

## WHO SHOULD ATTEND

- All engineers and technicians who endeavor to learn and practice the science and art of optical instrument design and engineering and want to have a complete working knowledge of the process from concept through to a finished engineering design package ready for manufacturing. These students should consider completing the certificate program.

- Individuals who want to have a working knowledge of any particular component of this program should complete those courses that apply to their interests

- All students taking the required courses will be allocated a current network license for Zemax Optical Design Software. Other optical design software programs may be reviewed by the instructor and other qualified representitives.

## PROGRAM BENEFITS

- Gain useful insights and practical skills for designing and engineering optical and optomechanical components and instruments.
- Learn how to understand details of optical and Optomechanical technical specifications to communicate effectively with manufacturer's and quality control functions.
- Develop innovative approaches for optical instrument design and analysis including tolerances.
- Some scholarship opportunities are available through the professional associations listed on the next page.

## CERTIFICATE REQUIREMENTS

An Optical Engineering certificate is awarded upon completion of 15 credit units: 4 required courses (2.5 units each), at least two elective courses (a minimum of 5 units total). A grade point average of “B” or better is required.

An Optical Instrument Design certificate is awarded upon the additional completion of 12 credit units: 2 required courses (Optomechanical 2.5 units each) and at least two more elective courses (a minimum of 5 units total) and a final project (2 units.) A grade point average of “B” or better is required.

## FOR MORE INFORMATION

Please call (949) 824-5380

## PROFESSIONAL ASSOCIATIONS OF INTEREST

Optical Society of America www.osa.org
Optical Society of Southern California www.ossc.org
UC Irvine OSA Student Chapter http://osa.ps.uci.edu/
The International Society for Optical Engineering www.spie.org
The Optics Institute of Southern California http://oisc.net

## ADVISORY COMMITTEE

**DONN M. SILBERMAN**, M.S., Committee Chair;
Founding Director, Optics Institute of Southern California;
Sr. Applications Engineer, PI (Physik Instrumente);
Past President OSSC 2007-2008

**VALENTINA DOUSHKINA**, M.Sc.; Lead Instructor; Director of Engineering, Qioptiq Polymer;
Vice President OSSC 2009-2010

Wytze van der Veer, Ph.D. Director of the UC Irvine Laser Spectroscopy Center, Chemistry Dept.

Bruce Tromberg, Ph.D. Director of the Beckman Laser Institute, UC Irvine

G.P. Li, Ph.D. Director, California Institute for Telecommunications and Information Technology, UC Irvine

Derek Dunn-Rankin, Ph.D., Chair, Mechanical and Aerospace Engineering, UC Irvine

Arnie Banzensky, Field Sales Manager, Schott Glass Technologies, Past President OSSC

Charles Gaugh, Technical Director & Sales Manager, Davidson Optronics, Past President OSSC

Jeff Padgett, Optomechanical Engineering Technician, Wavetec Vision, Inc.

Forrest Reynard, President, Reynard Corporation – Advanced Optical Solutions

Ed Arriola, Chief Engineer, LightWorks Optics

Mark Gallagher, Ph.D. Optical Science, J.D, Partner, Knobbe, Martens, Olson & Bear, LLP

T. Scott Rowe, Principal, Rowe Technical Design

James D. Trolinger, Ph.D., Co-Founder, MetroLaser, Inc.

Desiré Whitmore, Ph.D. Candidate, UC Irvine Chemical & Material Physics,
UC Irvine OSA Student Chapter President

## REQUIRED COURSES (10 units)

**Lens Design Part I**

This is an introductory hands-on lens design course. Until recently, lens design was a skill reserved for a few professionals, but today with readily available commercial design software and powerful personal computers, it is accessible to the general optical engineering community. Consequently some skill in lens design is now expected by a wide range of employers who utilize optics in their products. Lens design is, therefore, a strong component of a well-rounded education in optics, and a skill valued by industries employing optical engineers and technicians.

**(Advanced) Lens Design Part II**

In this course, the students learn about merit functions and how to contrast and use them to optimize their lens designs, set parametric variables and boundary constraints. More complex lens designs are reviewed in detail such as achromatic and multi-element lens systems.
*Prerequisite:* *Lens Design* Part I

**Optical System Design Part I**

This course then begins with modeling using coordinate breaks so that students can model components such as beam splitters, mirrors, tilts and decenters. Then modeling with multi-configuration systems such as interferometers, mutli-channel systems, zoom lenses, scanning and gradient index systems are reviewed.

*Prerequisite:* *Lens Design* Part II

**(Advanced) Optical Systems Design Part II**

Various default and custom merit functions for mutli-configured systems are reviewed with optimizations based on different parameters such as MTF, RMS and PTV. System analysis using geometric and diffraction optical parameters are reviewed with spot size, ray fan, OPD diagrams, field curvatures/distortion and aberrations as means to determine the optical performance of a system. Thermal analysis and system athermalization are introduced and used to design systems that can operate over a wide range of temperatures.

System Tolerancing including error budgets, construction and assembly errors, passive and active compensators, Monte Carlo statistical tolerance analysis, test plate fitting and alignment design and analysis. Physical optics is also introduced using Gaussian beam propagation, analysis and control and beam characterization for use with laser systems.

*Prerequisite:* *Optical System Design* Part I

**Optomechanical Component Design**

Current state-of-the-art optical and mechanical system design engineering tools like ZEMAX™ and 3D SolidWorks™ are used to bring our students to the level of professionalism required by employers. It is rare to find a person skilled in both optical and optomechanical engineering, which is a growing demand of employers, especially those in small companies and start-ups. This Optomechanical component design course begins the process of teaching about the performance specifications required in the preliminary designs of Optomechanical components that the optical elements are mounted. Exporting the optical designs from Zemax into Solid Works is an important step. Material selection for optical and mechanical components is reviewed, followed by various optical component mounting techniques for lenses, prisms, mirrors, filters and windows.

*Prerequisite:* *Intro Lens Design and Intro SolidWorks*

**Optical Instrument Design**

Once students complete the Optomechanical component design course, they are ready for the final course in the program that pulls all the material together and design complete optical instruments. Here the students can integrate the concept of tolerancing of optical and mechanical components as one complete integrated system. This course includes learning about design lens assemblies with moving parts, ‘wrapping’ mechanics around the complete optical system model, stray light considerations and packaging the complete system. There are also lessons on instrument alignment strategies and procedures and final system test considerations.

*Prerequisite: Optomechanical Component Design*

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The following **Elective Courses** are generally held on three consecutive Saturday s in a give month. Basic algebra, trigonometry, geometry and physics are prerequisites.

**Fundamentals of Optics I (Geometric) & II (Physical)**
This course is intended for students intending to use optics and photonics and to introduce them to the design and use of optical components and systems. This course surveys geometrical and wave (physical) optics covering prisms, lenses, mirrors and gratings for their use in optical systems. Selection of materials for optics is described. Special topics may include optics of aspherics, crystals and magneto-optic isolators. An introduction to eyeball optics, telescopes, microscopes, interferometers and other optical instruments is covered.

**Introduction to Lasers**
This course is intended to expose students to the basic physical and engineering principles of lasers and review different types of lasers. Topics include spontaneous and induced transitions between atomic levels, absorption and amplification, optical resonators, Gaussian beams, three- and four-level lasers, mode-locked and Q-switched lasers, and specific laser systems: Nd:YAG and other solid-state lasers; He-Ne, argon-ion, carbon dioxide lasers and other gas lasers; semiconductor diode lasers; and laser applications.

**Introduction to Fiber Optics**
This course introduces the student to the properties of light, characteristics and control of LEDs (light emitting diodes) and lasers, fabrication of optical fiber, transmission of information via light, and fiber-optic transmission networks are covered. Topics emphasize devices, system analysis and design, including internal and external laser modulation, light coupling to fiber, fiber waveguide dispersion, attenuation and scattering phenomena, connectors, couplers, splitters, amplifiers, photo detectors, and receivers for digital and analog applications. Class will analyze and design a fiber optic link.

**Optical Interferometry/Metrology**
Theory, design and demonstrations of commonly used interferometers will be presented. A commercial Fizeau-type interferometer will be used to make routine metrology measurements of precision optical components. Interferogram analysis by hand calculation will be compared with results from various freeware fringe analysis programs.

**Introduction to SolidWorks**
3D CAD solids modeling instruction topics include: parts, assemblies, documentation drawings, structural weldments, photorealistic rendering, animation, simple static stress analysis, and the **SolidWorks** DWG editor),demonstrate SolidWorks 2007-2008 w/Smartfeatures, and also – some specific information about OptoMechanical Design.

**Precision Motion Control for Advanced Optical Systems**
Micro and Nano positioning solutions for advanced optical systems are key to many high-tech instruments in many fields. This course provides the fundamentals for understanding these key motion control technologies as they are used in different technology fields from semiconductors to biotechnology and telecommunications.

**Introduction to Vibration Control**
(Summary to be added soon.)

Additional courses to be added – TBD.