The Institute of OPTICS

Undergraduate Handbook

Fall 2013

Dear Optics student,

It is my great pleasure to welcome you to The Institute of Optics. The Institute of Optics has been educating the next generation of leaders in the field since it was founded in 1929 as the first optics department in the country. Approximately half of all optics degrees awarded nationwide have been awarded by our institute. Optics and Photonics play an essential role in the development of cutting edge science, technology, innovations, and applications in critical areas such as health care, renewable energy, cybersecurity, communications, imaging, and defense. There is no question that you are entering the field of Optics at a very exciting time.

We have prepared this Undergraduate Handbook to serve as a guide and a resource for you. Please feel free to consult your faculty adviser or the Undergraduate Program Coordinator if you need further information or clarification on any content in this handbook.

I encourage you to take advantage of the many opportunities that are available to you through The Institute of Optics during your studies here. Our faculty and staff are dedicated to helping you succeed in your studies as you transition from an undergraduate student to a valuable professional in the field of Optics.

I wish you all the best in your academic and future professional endeavors.

Warm Regards,

Xi-Cheng Zhang
Director of the Institute of Optics
M. Parker Givens Professor of Optics

Introduction

This handbook provides a summary of information taken from various University of Rochester publications as well as program specific details unique to The Institute of Optics that are of importance to Optics majors and prospective Optics majors. This manual contains important information regarding changes to the Optics curriculum and should be read carefully and in its entirety. Policies and procedures that apply across the university take precedence over the policies and procedures contained in this handbook.

Updates to this document will be posted at both The Institute of Optics website and the Undergraduate Program Coordinator's "What's Hot" web page. You may access the Undergraduate Coordinator's web page at:

http://www.optics.rochester.edu/optics_major/undergrad_news.html.

This handbook is updated to reflect the curriculum changes that are effective as of Fall 2013. As a general rule, students will follow the curriculum that was in effect **at the time when the major was declared**. Recognizing that not all members of the Classes of 2015 and 2016 will be able to follow the curriculum that was in effect when entering the major, the Undergraduate Committee will evaluate each student's academic path on a case-by-case basis. See your adviser for more details.

Requirements for Admission to The Institute of Optics

Students normally apply for admission to the Institute of Optics during the second semester of their sophomore year by submitting a signed concentration approval form to the Undergraduate Program Coordinator. The entrance criterion for the Bachelor of Science (B.S.) Degree in Optics and B.S. degree in Optical Engineering are the same.

To be formally admitted to the concentration, students will need to satisfy the **all** requirements (see Appendix 1 for a copy of the Admission to The Institute of Optics form). Students must:

1. Have an overall grade point average (GPA) of at least 2.0 and not be on probation.

2. Have an average GPA of at least 2.0 in the following three physics courses: PHY 121, 122, 123 or PHY 141, 142, 143 (or in comparable courses taken elsewhere).

3. Have an average GPA of at least 2.0 in Math 161, 162, and 164 (or in comparable courses taken elsewhere).

4. Have a course grade of "C" or better in **both** OPT 241 and OPT 197. Additionally, students must have either completed OPT 261 and OPT 198 with a "C" or better in **both** classes **or** be currently enrolled in OPT 261 and OPT 198 with no mid-term warning letters issued.

5. Have a grade of "C" or better in WRT 105 College Writing.

Students who have not satisfied all of these requirements may be conditionally admitted at the Undergraduate Committee's discretion.

Note: The OPT 197 and OPT 198 labs will be renumbered to OPT 201 and OPT 202 effective Spring 2014.

Requirements for Graduation

To graduate, a minimum total of 129 semester hours are required for both the B.S. in Optics or the B.S. in Optical Engineering. A minimum cumulative GPA of 2.0 is necessary for all courses taken at The Institute of Optics as well as an overall GPA of 2.0.

In addition, the following requirements must be satisfied:

1. Completion of "Reason and Writing in The College" (WRT 105) or an equivalent course.

2. One **cluster** in either the humanities division or the social sciences division.

3. One **course** in the division not chosen for the cluster. Note: Completion of a minor or second degree in either of these academic divisions may also satisfy the minimum cluster requirement.

4. Completion of the MTH 161, 162, 164, and 165 sequence. An alternative approved sequence is MTH 171, 172, 173, and 174 (for those considered eligible by the Department of Mathematics). Students may also complete an alternative calculus sequence: MTH 141, 142 and 143.

5. One semester of introductory chemistry for science majors including the associated lab component; this requirement is commonly satisfied with CHM 131. (If you have AP credit, see your faculty adviser for additional guidance regarding the chemistry requirement)

6. Completion of PHY 121, 122, and 123 **or** PHY 141-143 (Mechanics, Electricity & Magnetism, and Modern Physics).

7. Completion of the following Optics core classes:

    a. OPT 197* Geometrical Optics Lab
    b. OPT 198* Physical Optics Lab
    c. OPT 199* Instrumentation Lab
    d. OPT 204** Sources and Detectors Lab
    e. OPT 223 Quantum Theory of Optics
    f. OPT 225** Optical Sources and Detectors
    g. OPT 241 Geometrical Optics
    h. OPT 242 Aberrations and Testing
    i. OPT 261 Interference & Diffraction

j. OPT 262 Electromagnetic Theory
k. OPT 287 Math Methods for Optics & Physics (or Math 282)
l. OPT 310 Senior Design I (Optical Engineering Majors Only)
m. OPT 311 Senior Design II (Optical Engineering Majors Only)
n. OPT 320 Senior Thesis I (Optics Majors Only)
o. OPT 321 Senior Thesis II (Optics Majors Only)

*OPT 197/198/199 will be renumbered to OPT 201/202/203 effective Spring 2014.
**New class/lab that will be introduced in Spring 2014.

8. Demonstrated competency in the design and implementation of simple analog and digital electronic circuits. Most students satisfy this requirement with ECE 210 (Circuits for Engineers), but alternative methods are possible. Consult your faculty adviser for guidance.

9. Completion of CSC 160 (Engineering Computing).

10. Students must complete **three** technical electives (12 credit hours) that provide mastery of an aspect of Optics initiating with a course required for the major. As a general rule, two credit courses do not satisfy the elective requirement.

Curriculum Change(s) Effective Fall 2013

The Undergraduate Committee completed a comprehensive review of the Optics curriculum during the 2012-13 academic year. As a result of this review, the following curriculum changes are effective Fall 2013:

1. OPT 224 (Lasers) has been retired. OPT 226 (Optoelectronics) is still required for the Class of 2014 but will be retired after the Fall 2013 semester. Course content will be consolidated into a single course called Optical Sources and Detectors (OPT 225). OPT 225 is to be taken in the spring semester of the junior year starting this academic year.

2. Optics 197/198/199 are now two-credit labs. As of Spring 2014, these labs will be re-numbered to OPT 201/202/203.

3. OPT 256 is still required for the Class of 2014 but will be retired after the Fall 2013 semester. The key components of this course will be distributed to Optics 310/320 and OPT 204 (see below).

4. OPT 204 will be a new required lab course that is paired with OPT 225. This course will be taken in the spring semester of the junior year starting this academic year.

5. MTH 281 is no longer a required course (it can be taken as a technical elective).

6. Three technical electives are now required.

7. MTH 163 no longer fulfills part of the required math sequence. Students will take MTH 165 (as opposed to having a choice between MTH 163/165).

8. The introduction of OPT 244: a new technical elective for students who wish to learn more about lens design. This course is an undergraduate version of OPT 444 (Lens Design).

Typical Four-Year Program in Optics

The B.S. degree in **Optics** **or** **Optical Engineering** consists of 129 credit hours of coursework. A typical program is shown below. Please note: the first 3 years are virtually identical for students pursuing either degree (all courses carry 4 credits unless otherwise indicated).

First Year

Fall	Spring
MTH 161	MTH 162
CHM 131 (5 cr.)	PHY 121
WRT 105 College Writing course	Cluster course or WRT 105
EAS 105 Introduction to Optics (recommended)	CSC 160 computing course

33 credits

Second Year

OPT 241 Geometric. Opt	OPT 287 Math Methods
OPT 197 Geometrical Optics Lab. (2 cr.)	OPT 261 Interference & Diffraction
MTH 164	OPT 198 Physical Optics Lab (2 cr.)
PHY 122	PHY 123
Cluster course or tech elective	Cluster course or tech elective

36 credits

Third Year

OPT 262 Electromagnetic Theory	OPT 225 Sources and Detectors*
OPT 242 Aberrations & Testing	OPT 204 Sources Lab (2 cr.)*
OPT 199 Instrumentation Lab (2 cr.)	OPT 223 Quantum Theory
MTH 165	Circuits (ECE 210 or equivalent)
Cluster course or tech elective	Cluster course or tech elective

36 credits

Fourth Year

OPT 310 Senior Design I	OPT 311 Senior Design II
OPT 320 Senior Thesis I	OPT 321 Senior Thesis II
Cluster, tech or free elective	Cluster, tech or free elective
Cluster, tech or free elective	Cluster, tech or free elective

24 credits

Total credits **129 semester hours**

Free Electives: Any credit course offered by the University of Rochester can be taken as a free elective.

Overlap Policy

For students who are seeking multiple majors, the following degree overlap policies should be kept in mind:

No more than **three** courses may overlap between any two majors [degrees].
No more than **two** courses may overlap between a major and a minor.

For more information regarding course overlaps, consult with your faculty adviser.

Advice on Course Selection

Program planning begins during Freshman Orientation and continues throughout a student's academic career at The University of Rochester. Each entering student is assigned a faculty adviser who helps with academic program planning during the undergraduate years.

When selecting Optics courses, please note that satisfactory completion of prerequisite courses is a requirement. Satisfactory completion means that the student received a course grade of C- or better.

Repeating an Optics Course

A student will be allowed to retake a given Optics course only once. Students who are not in compliance with these policies (satisfactory completion of prerequisite courses or repeating an Optics course) must obtain special permission from the Optics Undergraduate Committee before they are allowed to register for the next Optics course or courses; this is to be done by petition. Petition forms are submitted to the Committee via the Optics Undergraduate Program Coordinator, Daniel Smith (in Wilmot 106).

Clusters

Students must complete the foundation/distribution requirements in the humanities or social sciences by taking the appropriate divisional cluster. Students may also complete a minor or additional major in the humanities or the social sciences in lieu of a cluster.

As a general rule, students should endeavor to take only one cluster course, or one course towards a minor (or second major), per semester.

Upper-Level Writing Requirement

The upper-level writing requirement is satisfied with the following coursework: Either OPT 321 Senior Thesis II (for the BS in Optics) or OPT 311 Senior Design II (for the BS in Optical Engineering).

Optics Courses and Pre-requisites

101. Introduction to Optics
Begins with a discussion of the properties of light (refraction, imaging, diffraction, interference) and the historical development of optical instruments (microscope, telescope, and laser) before moving into topics such as the Internet, high-speed information access, information storage and display, and even new medical applications. Demonstrations. Prerequisites: None.

197. Geometrical Optics Laboratory (2 cr.) To be taken concurrently with OPT 241. (Note, this course will re-numbered to OPT **201** effective Spring 2014)

198. Physical Optics Laboratory (2 cr.) To be taken concurrently with OPT 261. (Note, this course will re-numbered to OPT **202** effective Spring 2014)

199. Instrumentation & Testing Laboratory (2 cr.) To be taken concurrently with OPT 242. (Note, this course will re-numbered to OPT **203** effective Spring 2014)

204. Sources and Detectors Lab (2 cr.) To be taken concurrently with OPT 225. (as of Fall 2013, this new course is pending College approval)

223. Quantum Theory of Optical Materials and Devices
Introduction to quantum mechanics in the context of modern optics and optical technology. Wave mechanics applied to electrons in crystals and in quantum wells. Pre-requisites: PHY 123 or 143 (may be taken concurrently).

225. Sources and Detectors
This core class provides basic concepts required for understanding the operation of optical sources and photodetectors. It also covers important sources such as lasers and light-emitting photodiodes as well as several different types of photodetectors. (as of Fall 2013, this new course is pending College approval)

226. Optoelectronics I: Devices
Introduction to the physics of optoelectronics. Light propagation in restricted geometries including waveguides and optical fibers. Dispersion and loss in linear and nonlinear pulse propagation. Passive optoelectronic devices: detectors and couplers. Active optoelectronic devices: lasers and modulators. Coupling between passive and between active and passive elements. Pre-requisites: OPT 261, OPT 262.

232. Optomechanical Design
Concepts required to achieving goals of optical system performance, combining of glass with metal or plastic, kinematic design, material limitations, effects of gravity and temperature. Applications to optical metrology, alignment, geometry 2D and 3D, and generation of precision diffraction gratings. Standards of straightness, flatness, roundness, and length.

241. Geometrical Optics
Optical instruments and their use. First-order Gaussian optics and thin-lens system layout. Photometric theory applied to optical systems. The eye, magnifier, microscope, matrix optics, nature of Seidel aberrations. Taken concurrently with OPT 197. Pre-requisites: MTH 161, Computing requirement.

242. Aberrations, Interferometry and Testing
Geometrical and diffraction theory of image formation. Optical transfer functions. Measurement of first-order properties. Seidel aberrations. Tests of aberrated systems. Seidel contribution formulae. Two beam interferometry. Interferometers in optical testing. Shearing, point diffraction, and heterodyne interferometers. Taken concurrently with OPT 199. Pre-requisites: OPT 241, 261.

243. Optical Fabrication and Testing Laboratory
Fabrication of a plane parallel plate, lens, or prism from a variety of optical glasses; controlled loose abrasive grinding pitch polishing skills; optical metrology, including interferometry and evaluation of roughness. Optics seniors only (or permission of instructor).

244. Lens Design
3rd order aberration theory, optimization theory, global optimization, variables and constraints of various lens materials and types. Course concludes with individual lens design projects.

246. Optical Interference Coating Technology
Optical interference in a multilayer stack and its application to anti-reflection coatings, beamsplitters, laser mirrors, polarizers, and bandpass filters. Prerequisite: OPT 262.

261. Interference and Diffraction
Complex representation of waves; scalar diffraction theory; Fresnel and Fraunhofer diffraction and application to measurement; diffraction and image formation; optical transfer function; coherent optical systems, optical data processing, and holography. Taken concurrently with OPT 198. Pre-requisites: MTH 164; PHY 122 or 142.

262. Electromagnetic Theory
Vector analysis, Maxwell's equations, energy flow in electromagnetic fields, dipole radiation from Lorentz atoms, partially polarized radiation, spectral line broadening, dispersion, reflection and transmission, crystal optics, electro-optics, quantum optics.
Prerequisites: MTH 163, 164; PHY 122 or 142.

287. Math Methods in Optics and Physics
This course introduces techniques used in mathematical study of optical phenomena. Emphasis is placed on gaining insight and experience in the use of these powerful and elegant tools for describing, solving and resolving optical systems and schema.

310. Senior Design I
Under faculty supervision, preparation for year-long work among teams to outline specifications, project planning, and project development will include design alternatives and subsystem segmentation discussions.

311. Senior Design II
Teams work with professors or companies to bring design projects to fruition by semester's end.

320. Senior Thesis I
Under faculty supervision, preparation for year-long independent research or participation in ongoing graduate group research.

321. Senior Thesis II
Culmination of research, experimentation and data collection, into a cohesive, scientific thesis and presentation of results.

391. Independent Study
The objectives and content of independent study courses are determined in consultation between specially qualified matriculated students and full-time members of the teaching faculty.

Optics Foundation (required for major) Courses at a Glance

CHM 131	Chemical Concepts, Systems & Practices I (5 cr.)
CSC 160	Engineering Computing
ECE 210	Circuits for Scientists and Engineers
MTH 161	Calculus IA
MTH 162	Calculus IIA
MTH 164	Multidimensional Calculus
MTH 165	Linear Algebra with Differential Equations
OPT 197	Geometrical Optics Laboratory (2 cr.)
OPT 198	Physical Optics Laboratory (2 cr.)
OPT 199	Instrumentation & Testing Laboratory (2 cr.)
OPT 204	Sources and Detectors Lab (2 cr., effective Spring 2014)
OPT 223	Quantum Theory of Optics
OPT 225	Optical Sources and Detectors (Effective Spring 2014)
OPT 241	Geometrical Optics
OPT 242	Aberrations, Interferometers, and Testing
OPT 261	Interference and Diffraction
OPT 262	Electromagnetic Theory
OPT 287	Mathematical Methods for Optics and Physics
OPT 310/311	Senior Design I/II (Optical Engineering majors only)
OPT 320/321	Senior Thesis I/II (Optics majors only)
PHY 121	Mechanics
PHY 122	Electricity and Magnetism
PHY 123	Modern Physics
WRT 105	Reason & Writing in the College

Technical Electives [Themes]

As of Fall 2013, three technical electives are required. It is the student's responsibility to check semester schedules to know when or if a course is offered and to check the course descriptions for pre-requisites. See Appendix (2) for a listing of approved technical electives and suggested themes. If you wish to take a course outside of the list, consult with your faculty adviser.

B.S.-M.S. Program in Optics

As of Fall 2013, the B.S.-M.S. Program is no longer available. However, students who intend to pursue a higher degree at The Institute of Optics may plan to take up to eight hours of graduate courses as undergraduates. Two graduate courses may apply to a higher degree so long as those credits do not fulfill any requirement for the Bachelor's degree.

Study Abroad

The Institute of Optics highly encourages its students to take advantage of the University's study abroad program. Students interested in study abroad should consult with their faculty adviser in order to fully understand the options for, and implications of, studying abroad. Studies abroad is available for juniors, first semester seniors, and select sophomores. For more information, see the Center for Study Abroad and Interdisciplinary Programs' website:

http://www.rochester.edu/college/abroad/

HSEAS "Take Five" Program

Take Five is a program designed to provide students with the opportunity to acquire a broader liberal arts education that might not otherwise be available to them. The intent of the proposed program is to further a student's general education, not to further employment-related goals. Vocationally-related programs will most likely be rejected. Take Five courses cannot be used in any way to satisfy graduation, major, minor or cluster requirements.

Students will be allowed either a ninth semester or a fifth year without additional tuition charges in order to take courses outside their field of concentration. Students may apply when they have been accepted into an area of concentration, but no later than second semester of their junior year.

Guidelines for the *Take Five* Program:

1. The intent of the proposed program is to further a student's general education.

2. A substantial number of the proposed additional courses should relate to one another and not be a random sampling of unrelated subjects.

3. None of the additional courses can be in the same department in which the student is majoring.

4. No more than one-quarter of the additional courses can be in subjects closely related to the major.

5. Proposals to study away from the University will normally be through programs that are sponsored by or affiliated with the University of Rochester.

6. The student will spend the fifth year enrolled at courses at UR.

7. The student will not earn an additional degree through *Take Five*.

Application due dates:
November 1 in the Fall Semester
The first Thursday after Spring Recess in the Spring Semester

Detailed T5 information can be found at:

http://www.rochester.edu/college/CCAS/students/opportunities/takefive/

Information for Transfer Students

Students who transfer into the Optics major as a junior either from another major within the University of Rochester, or from another college or university sometimes find it difficult to complete the Optics degree requirements in only two additional years. In practice, most students in this position take two, two-and-one-half, or three years to complete the major. However, it may be possible to complete the degree in two years if a student has the calculus and physics and perhaps the cluster requirement fulfilled. The best course of action for any student depends on the details of the student's educational background and should be discussed with a faculty adviser.

The Optics Minor

Students interested in completing a minor in Optics should meet with a faculty member of the Institute of Optics to plan a focused program of study. Optical sciences and technologies have great importance in a range of fields and applications, and a stronger grasp of the field is a desirable option, particularly for majors in other science and engineering disciplines.

The requirements for a minor in Optics are satisfied by earning grades of C or better in five Optics courses, one of which must be laboratory-based. Two courses are required: Optics 241 and 261. The lab component may be satisfied by OPT 197, 198, 199, or 256, or by independent research for credit. The remaining two courses can be chosen among those offered by the Institute at the 200 level or above. Paid internships do not qualify as independent research.

Students interested in the Optics minor should note that most 200-level Optics classes have pre-requisites in math and/or physics that must also be satisfied, unless permission of the instructor is obtained.

BME Majors with a “concentration track” in Optics take note: Your track requires OPT 241 and OPT 261 so the minor in Optics will need electives that you do not also use for your track. Review your courses with an Optics faculty adviser.

Exceptional Circumstances

Occasionally, scheduling conflicts or program changes prohibit a student from completing an intended cluster, or a student is unable to complete the requirements for the degree as laid out in the University Bulletin. Extenuating circumstances may merit waiving certain requirements or reviewing alternate relevant experience that will enable the student to obtain a degree.

If such circumstances are presented via petition, they will be considered on a case-by-case basis. The Undergraduate Committee of The Institute of Optics reviews petitions pertaining to the major and departmental requirements. The Administrative Committee of the School of Engineering and Applied Sciences reviews petitions pertaining to School or College requirements. Petition forms for these two committees are available from the Undergraduate Program Coordinator.

Undergraduate Committee

The Undergraduate Committee is responsible for Optics curriculum content and the policies and procedures found in this handbook. The Undergraduate Committee meets approximately once per month during the academic year and is made up of the professors listed below:

Prof. Govind Agrawal (Chair)	Goergen 515, 5-4846	gpa@optics.rochester.edu
Prof. Julie Bentley	Goergen 507, 3-1687	bentley@optics.rochester.edu
Prof. Andrew Berger	Goergen 405, 3-4724	ajberger@optics.rochester.edu
Prof. Tom Brown	Goergen 517, 5-7816	brown@optics.rochester.edu
Prof. James Zavislan	Goergen 416, 5-9819	zavislan@optics.rochester.edu
Prof. David Berg		daberg@optics.rochester.edu

The primary administrative point of contact for committee matters (e.g. petitions) is the Undergraduate Program Administrator:

Daniel Smith	Wilmot 106, 5-7764	daniel.smith@rochester.edu

Freshman and Pre-Major Advisers

The following faculty members serve as freshman and pre-major advisers:

Prof. Miguel Alonso	Wilmot 213, 5-7227	alonso@optics.rochester.edu
Prof. Govind Agrawal	Goergen 515, 5-4846	gpa@optics.rochester.edu
Prof. Nick Vamivakas	Wilmot 214, 5-2089	nick.vamivakas@rochester.edu
Prof. Gary Wicks	Wilmot 109A, 5-4867	wicks@optics.rochester.edu

Appendix 1: Application for Admission to Optics Major

Name: _____ Date: _____

ID: _____

A. I hereby apply for admission to the Optics major. My intended major is (circle one):

BS in Optics (OPT) BS in Optical Engineering (OPE)

B. I have completed the following requirements for admission (check all that apply):

_____Primary Writing (WRT 105) requirement is satisfied

_____I am **not** on probation

_____I have a 2.0 GPA or better in PHY 121, 122, and 123. If currently enrolled in PHY 123, I have not received a mid-term warning letter this semester.

_____I have a 2.0 GPA or better in MTH 161, 162, and 164

_____I have completed OPT 241 **AND** OPT 197 with a grade of "C" or better in each course

_____I am enrolled in, or have completed, OPT 261 **AND** OPT 198 and have not received a mid-term warning letter

If all requirements above are not completed, indicate courses in progress this semester:

For students who **have not** completed all required admission requirements, complete section C below. For students who **have** met all of the above requirements, skip section C and proceed to signature block.

C. I understand that I am being conditionally admitted to the Optics major and agree to complete all admissions requirements by the end of the _____ semester. I understand that failure to complete the standard requirements for admission to the department may result in being dropped from the major. _____ (**student initials**)

_____

_____ _____

Student Signature Faculty Adviser Signature

Appendix 2: Optics Technical Electives

As of Fall 2013, **three** technical electives are required. ***Suggested*** technical elective themes are listed in blue in the first row of the table below. Choose classes in the vertical column below the technical elective theme you wish to pursue or consult your advisor for additional class themes and/or combinations.

Biomedical Optics	Optics + Math	Lens Design	Photonic Devices	Photonic Materials	Optics & Physics	Lab Special	Lasers and Photonics	Optomechanics
OPT 241	**OPT 287**	**OPT 241**	**OPT 226**	**OPT 226**	**OPT 223**	**OPT 204**	**OPT 225**	**OPT 242**
OPT 248	MTH 2XX	OPT 243	ECE 235	ME 280	PHY 235	OPT 253	ECE 235	ME 226
OPT 276	MTH 2XX	OPT 244	OPT 468*	OPT 421*	PHY 227	OPT 257	OPT 465*	OPT 232
PHY 253	MTH 2XX	OPT 246			PHY 246	PHY 243W	OPT 468*	OPT 432*
BME 270		OPT 247						
		OPT 444*						

*For students pursuing graduate studies at The Institute, these courses cannot count for both the Bachelor's and Master's degrees in Optic

Class	Title
OPT 204	Sources Lab
OPT 223	Quantum Theory of Optics
OPT 225	Sources and Detectors
OPT 226	Optoelectronic Devices
OPT 232	Opto-Mechanics
OPT 241	Geometrical Optics
OPT 242	Aberrations and Testing
OPT 243	Optical Fabrication and Testing
OPT 244	Lens Design
OPT 246	Thin Film Coatings
OPT 247	Advanced Optical Coatings
OPT 248	Vision and the Eye
OPT 253	Quantum Optics Lab
OPT 257	Advanced Senior Laboratory
OPT 276	Biomedical Optics
OPT 287	Math Methods
OPT 421	Optical Properties of Materials
OPT 432	Intro to Optomechanics
OPT 444	Lens Design
OPT 465	Laser Systems
OPT 468	Waveguide Optoelectronic Devices
BME 270	Biomedical Microscopy
ECE 223	Semi-Conductor Devices
ECE 235	Intro to Optoelectronics
ME 226	Intro to Solid Mechanics
ME 280	Intro to Material Science
MTH 2XX	Any upper division math course
PHY 227	Thermo and Stat Mechanics
PHY 235	Advanced Classical Mechanics
PHY 243W	Advanced Lab Topics
PHY 246	Quantum Theory
PHY 253	Biological Physics