

**PHYSICS 411/611, ECE 411/611
OPTICS FOR SCIENTISTS AND ENGINEERS
Syllabus, Fall Semester 2020**

| | | | |
|-------------------------------|-----------------------------------|------------------------|--|
| Lectures: | 12:30-1:45 T/Th | Room: | South Engineering 120 |
| Semester Credit Hours: | 3 | | |
| Instructors: | Department | Office: | Phone: |
| Dr. Andrew B. Croll | Physics | South Engineering 212B | 413-320-3810 Andrew.Croll@ndsu.edu |
| Dr. Ivan T. Lima Jr. | Electrical & Computer Engineering | 101-E E.E. Bldg | 231-6728 Ivan.Lima@ndsu.edu |
| Dr. David A. Rogers | Electrical & Computer Engineering | 101-J E.E. Bldg | 231-7216 David.Rogers@ndsu.edu |

Office Hours: (Dr. Croll) 9:00-12:00 M,
South Engineering 212B or via Zoom (email for link)

TEXT: *Optics* (Fifth Edition) by Eugene Hecht
Physics/ECE 411 Prerequisite: Physics 252, University Physics II
Physics/ECE 611 Prerequisite: Physics 252, University Physics II or equivalent
Corequisite: Physics 411L/611L or ECE 411L/611L

Course Objective:

The goal of this course is to provide students with the fundamentals necessary to enable them to successfully apply optics in their respective disciplines. This will be accomplished through hands-on use of state-of-the-art equipment in the co-requisite laboratory course in conjunction with classroom discussions to experience and understand the most important concepts and phenomena of optics.

Expectations:

In accordance with NDSU [Policy 601](#), failure to comply with instructions, including this syllabus, may be handled according to the Code of Student Conduct resolution process and may result in disciplinary sanctions.

Health and Safety:

While masks are not required as we begin the 2022 fall semester, NDSU administration has determined that faculty may request mask use in their classroom. In this class, **I ask that you wear a mask** to help protect my health and the health of your peers.

Where possible, please spread out within the classroom, including not sitting in the first row of the classroom, to maximize social distancing.

Attendance Expectations:

According to [NDSU Policy 333 \(www.ndsu.edu/fileadmin/policy/333.pdf\)](http://www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected, but this will be flexible. The course is taught to the classroom, but is broadcast on zoom (and recorded) for emergencies.

Please do not come to class:

- if you are feeling ill, particularly if you are experiencing COVID-19 symptoms, or
- if you are infected, during your five-day isolation period.

You will still need to complete the assignments, exams, reading, etc. necessary to meet class learning objectives. You can complete missed work by arranging a late submission with the instructor. If you are going to miss an exam for a valid excuse, e-mail or telephone your instructor before the test or on the same day. Phone number and e-mail address are listed above.

If you were exposed to COVID-19, please follow CDC guidance.

If you test positive for COVID-19, please follow CDC guidance.

Food and drink is not permitted in class unless a student has a documented accommodation through Disability Services. Students will have to remove their masks to eat or drink.

Veterans and student service members with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

Lecture attendance will not be directly factored into the final grade, but active daily participation is essential. Students are expected to read the day's lesson prior to coming to class and to be prepared to discuss it in class. Material may be presented that is not in the text or it may be presented in a different way. Students are responsible for all material presented in class including that missed during excused absences. If you miss a class, it is your responsibility to view recorded classes and discuss with peers.

BlackBoard:

Course assignments, information, and messages will be posted to BlackBoard <http://bb.ndsu.nodak.edu/>

Technical Issues:

We will use lots of software, if you have trouble with any of it contact NDSU Help Desk:

Email: ndsu.helpdesk@ndsu.edu

Call: 701-231-8685 (option 1)

Group Homework:

Problem solving is a primary learning method for this course. Homework will be emphasized and assigned in groups. You will be assigned to a homework group, optimally 4 members, for the semester. **Each student in the group must complete or attempt each problem** and the group will then meet to compare results and to group solve the more difficult problems. One legible problem solution set per group will be turned in on 8 1/2" x 11" paper ONE SIDE ONLY. SHOW all work. GIVE ALL EQUATIONS before substituting numerical quantities into them and always give the UNITS INVOLVED. UNDERLINE all answers. The students in the group may be asked to present

and/or discuss their solutions in class. Each group needs to decide on their group rules such as when you will meet, what the consequences are for members that don't show up/contribute, rotation for preparing the solutions to hand in, rotation for presenting solutions in class, etc. STUDENTS ARE ENCOURAGED TO MEET VIA ZOOM. ASSIGNMENTS ARE TO BE TURNED IN DIGITALLY – photos are acceptable but must be legible. Camscanner software is suggested as this usually produces nice single PDF output.

Composition of Final Course Grade:

The final grade will be determined as follows:

| Physics/ECE 411 | | Physics/ECE 611 | |
|-----------------|-----|-----------------|-----|
| Exam 1 | 20% | Exam 1 | 20% |
| Exam 2 | 20% | Exam 2 | 20% |
| Exam 3 | 20% | Exam 3 | 20% |
| Homework | 20% | Homework | 20% |
| Project | 20% | Project | 20% |

A total average of 89.5% of the possible points or more ensures an A, 75.5 to 89.4% ensures a B, 59.5 to 75.4% ensures a C, 49.5 to 59.4 ensures a D and below 49.5 will be an F. Depending on the class average, curving may be applied to grades; however the **lowest** passing final grade (C or higher) in the course will always be 50% or higher.

The exams will include conceptual questions requiring short answers, derivations, and quantitative problems similar to the assigned homework problems.

Graduate students will be assigned to a graduate homework group and will be assigned additional, more complex, homework. Graduate students will be graded separately on exams and the major related project and will be expected to have a more comprehensive understanding of the material.

Americans with Disabilities Act for Students with Special Needs:

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the [Disability Services Office \(www.ndsu.edu/disabilityservices\)](http://www.ndsu.edu/disabilityservices) as soon as possible.

Academic Honesty Statement:

The academic community is operated on the basis of honesty, integrity, and fair play. [NDSU Policy 335: Code of Academic Responsibility and Conduct](#) applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the [Office of Registration and Records](#). Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Additional Resources for Students:

Encourage use of support resources

As a member of the NDSU community, resources are available for you should you need help in dealing with adverse reactions to things happening in the world today. A variety of resources are listed below:

For students on campus and remotely (telehealth):

Counseling Services: 701-231-7671; <https://www.ndsu.edu/counseling/>

Disability Services: 701-231-8463; <https://www.ndsu.edu/disabilityservices/>

Student Health Service: 701-231-7331; <https://www.ndsu.edu/studenthealthservice/>

Dean of Students Office: 701-231-7701; <https://www.ndsu.edu/deanofstudents/>

In a crisis or emergency situation:

Call University Police: 701-231-8998

Call 9-1-1

Go to a Hospital Emergency Room

Go to Prairie St. Johns for a Needs Assessment: 701-476-7216 (510 4th St. S.)

Call the FirstLink Help Line: 1-800-273- TALK (8255) or 2-1-1

Call Rape and Abuse Crisis Center: 701-293-7273

Course description:

Today, light pervades our lives in ways that could not have been imagined a few decades ago. Light is at the core of technologies ranging from computing and communications to surgical techniques. Optics, the study of light, plays the role of an enabling science since it touches essentially every field of technology.

This is a 3 semester-credit-hour senior undergraduate/first year graduate level course with minimum course prerequisites (University Physics II, electricity and magnetism) and the co-requisite Physics/ECE 411L/611L. Lectures will be based on the text *Optics, Fifth Edition*, by Hecht to provide the background required for performing the experiments.

The anticipated schedule is as follows:

First twelve weeks—three one-hour lectures per week, except holidays

Three weeks—laboratory five-hours per week to work on major-related experiment

Dead week—students present results—three classroom hours

A major experiment related to the student's academic major (engineering, chemistry, physics, etc.) using optics will be selected by groups of three to four students for the last four-week project. Students will present their results to the class during Dead Week and write a research paper on this experiment that is due in lieu of a final exam. Students will be graded in this course on their paper, their presentation and their explanation of the results and will receive a separate laboratory grade based on their experimental apparatus and approach.

Tentative Course Outline:

| Week | Topic | Text Assignment |
|------|--------------------------|--------------------|
| 1 | Properties of waves | Ch 1, 2 |
| 2 | EM nature of light | Ch 3.1-3.4 |
| 3 | Dispersion | Ch 3.5-3.6 |
| 4 | Index of refraction | Ch 4.1-4.5 |
| 4 | Exam 1 Thursday, Sep 17 | Ch 1-3 |
| 5 | Reflection S/P | Ch 4.6-4.9 |
| 6 | Lenses, stops | Ch 5.1-5.3 |
| 7 | Mirrors/prisms | Ch 5.4-5.5 |
| 8 | Fiber optics and sensors | Ch 5.6 |
| 8 | Exam 2 Thursday, Oct 15 | Ch 4-5 |
| 9 | Vibrations. Waves | Ch 7.1-7.2 |
| 10 | Polarization | Ch 8.1-8.2 8.5-8.6 |
| 11 | Interference | Ch 9 |
| 12 | Diffraction | Ch 10 |
| 12 | Exam 3 Thursday, Nov 12 | Ch 7-10 |
| 13 | Major related project | |
| 14 | Major related project | |
| 15 | Major related project | |
| 16 | Present results | |
| 17 | Paper due Monday Dec 12 | at 1:00 PM |

| Name Description Rubric Detail | | 41 W811 Major Project Presentation Rubric | | | |
|--------------------------------------|---|---|---|---|--|
| | | Levels of Achievement | | | |
| Criteria | A | B | C | D | |
| | Selection of topics | 18 to 20 points Topic was highly appropriate for the course. Level of scientific difficulty appropriate for a 3 week project. | 16 to 17 points Topic was mostly appropriate for the course. Level of scientific difficulty appropriate for a 2 week project. | 14 to 15 points Topic was somewhat appropriate for the course. Level of scientific difficulty appropriate for a 1 week project. | 12 to 13 points Topic had little correlation with the course. |
| Introduction | 6 to 5 points Presents a concise lead-in to the presentation, including optics phenomenon to be demonstrated or tested. | 4 to 4 points Gives too much information—more like a summary. | 3 to 3 points Gives information but does not give a compelling reason why the topic is of interest. | 2 to 2 points Gives little information about what to expect in the presentation. | |
| Presentation of Experiment | 18 to 20 points Good diagrams, descriptions are succinct and explanatory. All visual/audio aids are relevant to topic or support the presentation. Visual/audio aids are complete, easy to understand, and easy to see/hear. | 16 to 17 points Good diagrams, descriptions are too long or do not contain enough pertinent information. Most visual/audio aids are relevant to topic or support the presentation. Visual/audio aids are somewhat easy to understand and see/hear. | 14 to 15 points Descriptive, but too much information is presented. Poor diagrams. | 12 to 13 points Hard to understand what was done and/or how things work. | |
| Results | 18 to 20 points Results of data analysis succinctly summarize the data taken, is well understood by group and leads to the conclusion. | 16 to 17 points Results of data analysis reasonably well understood by group but do not lead directly to conclusion that is made. | 14 to 15 points Results of data analysis poorly understood by group or not related to conclusion. | 12 to 13 points Results of data analysis are missing or not related to conclusion. | |
| Conclusion | 9 to 10 points Presents a logical explanation for findings; uncertainties covered and the suggested improvements take into account the effects of the assumptions. | 8 to 8 points Presents a logical explanation for findings; mistakes in uncertainties or in the suggested improvements and how they relate to the assumptions. | 7 to 7 points Presents a fairly logical explanation for findings but the discussion was a little hard to follow; mistakes in uncertainties or no improvements suggested. | 6 to 6 points Presents an illogical explanation for findings and does not address what was learned from the observations and/or what was proven in the testing; no uncertainties or no improvements mentioned. | |
| Overall presentation | 9 to 10 points Smooth transitions, ideas and slides flow effectively, topic presented in a logical order. Little or no use of technical jargon, all technical words appropriately defined. | 8 to 8 points Most transitions smooth, ideas and slides flow reasonably well, presentation fairly easy to follow. | 7 to 7 points Some group members were hard to understand. Choppy transitions, ideas, and slide flow. Presentation difficult to follow. | 6 to 6 points Group members were hard to understand, work was incomplete or hastily done. | |
| Total Group Knowledge Timing | 9 to 10 points All members shared equally and were equally knowledgeable and talk finished in ~20 min. All questions answered. | 8 to 8 points Most members participated equally and were equally knowledgeable, but one didn't or timing wasn't good. Most questions answered. | 7 to 7 points One group member did all of the work, or group was not able to complete talk within ~ 20 min. Some questions unanswered. | 6 to 6 points One group member did all of the work, and group was not able to complete talk within ~ 20 min. Unable to answer questions. | |
| Participation in Class Presentations | 5 to 5 points Attended all presentations and remained attentive. | 4 to 4 points Unexcused miss of one presentation. | 3 to 3 points Unexcused miss of two presentations. | 0 to 0 points Unexcused miss of three presentations. | |

View Associated Items

| Name Description Rubric Detail | | 4110511 Major Project Paper Rubric | | | |
|--------------------------------------|--|--|---|---|--|
| | | Levels of Achievement | | | |
| Criteria | A | B | C | D | |
| Selection of topics | 18 to 20 points Topic was highly appropriate for the course. Level of scientific difficulty appropriate for a 3 week project. | 16 to 17 points Topic was mostly appropriate for the course. Level of scientific difficulty appropriate for a 2 week project. | 14 to 15 points Topic was somewhat appropriate for the course. Level of scientific difficulty appropriate for a 1 week project. | 12 to 13 points Topic had little correlation with the course. | |
| Abstract | 5 to 5 points Clearly and concisely states the paper's purpose which is engaging and thought provoking. | 4 to 4 points Clearly states the paper's purpose. | 3 to 3 points States the paper's purpose. | 2 to 2 points The statement is incomplete and/or unfocused. | |
| Introduction | 5 to 5 points The introduction is engaging, states the main topic and previews the structure of the paper. | 4 to 4 points The introduction states the main topic and previews the structure of the paper. | 3 to 3 points The introduction states the main topic, but does not adequately preview the structure of the paper. | 2 to 2 points There is no clear introduction or main topic, and the structure of the paper is missing. | |
| Background Section | 14 to 15 points Comprehensible to the average 4110511 student. Relation of optics to project is clearly and concisely explained. Relevant equations are clearly and correctly explained. | 12 to 13 points Relation of optics to project is correctly explained. Equations are correctly explained. | 10 to 11 points Some optics concepts and principles are missing and/or inappropriate. | 9 to 9 points Relation of optics to project is unclear. | |
| Experimental Section | 14 to 15 points Good diagrams, descriptions are succinct and explanatory. Sufficient information provided so that another optics student could reproduce your results. | 12 to 13 points Good diagrams, descriptions are too long or do not contain enough pertinent information. | 10 to 11 points Descriptive, but too much or too little information is presented. Poor diagrams. | 9 to 9 points Hard to understand what was done and/or how things work. | |
| Results and Discussion | 19 to 20 points Results discussed in terms of the optics that we covered in class or optics that you learned in researching your major experiment. Knowledge of optics is clearly and correctly applied to evaluate aspects of the project. Thoughtful explanation if you didn't get results or the results weren't what you expected. Conclusions are clearly articulated. | 16 to 17 points Conclusions and logic are clear. Knowledge of optics is correctly applied but not at the level appropriate for 4110511. | 14 to 15 points Most relevant information present. Application of optics to interpret the project results is mostly correct. | 12 to 13 points Optics concepts are incorrectly applied. Conclusions are unclear. | |
| References | 9 to 10 points References are primarily peer reviewed professional journals or other approved sources. The reader is confident that the information and ideas can be trusted. | 8 to 8 points While most references are professionally legitimate, a few are questionable, e.g., trade books, internet sources, popular magazines. The reader is uncertain of the reliability of some of the sources. | 7 to 7 points Most of the references are from sources that are not peer reviewed and have uncertain reliability. The reader doubts the accuracy of much of the material presented. | 6 to 6 points There are virtually no sources that are professionally reliable. | |
| English Grammar and Spelling | 9 to 10 points 5-10 pages including figures. No spelling or grammatical errors found by Word's spell checker. | 8 to 8 points Contains a few errors, which may annoy the reader but not impede understanding. | 7 to 7 points Contains several errors, which may temporarily confuse the reader but not impede the overall understanding. | 6 to 6 points Numerous spelling and grammatical errors. Writing seems scattered/disorganized. | |

| Major Project Lab Component Rubric | | Levels of Achievement | | | |
|------------------------------------|---|--|--|---|--|
| Name | Description | A | B | C | D |
| Rubric Detail | This rubric is used to grade the portions of the presentation and paper relevant to the 411L/611L lab course. | | | | |
| Criteria | | | | | |
| Selection of topic | | <p>18 to 20 points Project selected is within the level of scientific difficulty covered in 411/611. Project is ambitious enough to constitute a 3 week project. Equipment is available to complete the project.</p> | <p>16 to 17 points Level of difficulty is more appropriate for a 2 week project or parts of the project are not possible due to lack of appropriate equipment.</p> | <p>14 to 15 points Level of difficulty is more appropriate for a 1 week project or project is impossible due to poor planning of equipment requirements.</p> | <p>12 to 13 points Relation of optics to project is unclear.</p> |
| Description of Experiment | | <p>18 to 20 points All experimental details are covered, and all trends and data comparisons are interpreted correctly. A good understanding of results is conveyed. Group displays a good grasp of data and uncertainty analysis techniques.</p> | <p>16 to 17 points Important experimental details are covered, but some minor details missing. Most results have been correctly interpreted and discussed. Group has some familiarity—but not facility—with data and uncertainty analysis techniques.</p> | <p>14 to 15 points Missing important experimental details, but some results have been correctly interpreted and discussed. Group displays rudimentary understanding of data and uncertainty analysis techniques.</p> | <p>12 to 13 points Missing several important experimental details. Very incomplete or incorrect interpretation of trends and comparison of data. Group displays no understanding of data and uncertainty analysis techniques.</p> |
| Data | | <p>18 to 20 points Data for every measurement are provided. Data are clearly presented.</p> | <p>16 to 17 points Data sets are not clearly presented.</p> | <p>14 to 15 points Data sets are incomplete.</p> | <p>12 to 13 points Data sets are inadequate for determining results.</p> |
| Plotting and fitting data | | <p>18 to 20 points Best-fit functions are properly chosen and presented as solid lines in your plots. Experimental points are plotted on the same graph. Axes and legends are properly labeled.</p> | <p>16 to 17 points Fits are provided but not fully described. Labeling is not complete.</p> | <p>14 to 15 points Labeling and legends are missing.</p> | <p>12 to 13 points Fits are not appropriate for data.</p> |
| Results | | <p>18 to 20 points Results found and conclusions reached are clearly presented.</p> | <p>16 to 17 points Some conclusions are inconsistent or incorrect for the collected data.</p> | <p>14 to 15 points Significant aspects of the experiment and theory are discussed incorrectly.</p> | <p>12 to 13 points Discussion of results is missing.</p> |