Syllabus: Light and Color (PHYS 1230)

Spring 2024; Dr. Bethany Wilcox

Basic Course Information

Lectures are Tues/Thurs 11:00 AM – 12:15 PM in Duane G1B30.

Instructor:
Dr. Bethany Wilcox
Office: Duane F1017 (10th floor of Duane tower)
Email: Bethany.wilcox@colorado.edu
Help hours: See table below
Office hours: By appointment (email to schedule)

All office hours:

Day	Staff	Location
Tuesday – 3-4pm	Dr. Wilcox	G2B70 (Help Room in basement)
Tuesday – 4-5pm	TA	
Wednesday – 3-4pm	Dr. Wilcox	

Materials and Texts

Required:

The only item you will need to purchase is an iClicker. Our required text is free.

1. ***Canvas.*** The course will run almost entirely via the learning management system Canvas. It will serve as our official website where all assignments, class notes, class information, and announcements will be posted.
2. ***OpenStax Texts***. Good news, your textbook for this class is free online! We will use selected chapters in *College Physics* and *Psychology*. Available at https://openstax.org/subjects. Accessible online, through a downloadable PDF
3. ***iClicker*** voting device or iClicker student app. Available from the bookstore or OIT's website. Register online (see instructions at https://oit.colorado.edu/services/learning-spaces-technology/cuclickers-iclickers)

Optional texts:

1. *Seeing the Light,* David Falk (Available at bookstore and online, copies on reserve in Gremill) – this book is not required to keep the course costs down; however, it is a very good resource and recommended particularly for students who learn well from books.

Course Information

This is a course about the science of optics: Light, vision, and visual perception. In other words, what we see, how our eye sees it, and how our brain makes sense of it. Without these three things, we would not be able to observe the world as we do. Many of the observations that we make in our lives – whether we're an architect or a scientist or an artist – rely to some degree on the nature of light, and how we perceive that light. Also, it is easy for our visual systems to be "fooled" – to think that we see something that we do not. Thus, it is important to understand visual perception in order to recognize where the connection breaks down between what *is* (i.e., the world, especially light) and what we *perceive* (i.e., what our brain tells us is out there.)

We are all born exploring the world, just watch any toddler. We all observe the world, try to make sense of it, and use that information to figure out the best course of action. When in a new apartment, for example, you might have to fiddle with the water faucet – it doesn't turn on when pushed side to side, but oh – if you push the lever up, then water comes out. In those few seconds you have taken data, made observations, come to a conclusion, and acted on that conclusion.

In this course, I hope to help you get in touch with your inner scientist – your curiosity and interest in fiddling with the world, poking it to see what happens – within the field of optics. We will explore many areas of optics that I find fascinating, and which we can directly observe – pinhole images, mirrors, lenses, our eye, our perception of color and depth, art and photography. We will use the language and tools of physics to explore, to notice, to wonder, and to draw conclusions about the world. We will use demonstrations, mini-experiments, and observations from your own life.

This class is fundamentally interactive. You will have many opportunities to engage in this content, including group work and clicker questions, worksheets, discussion forums, and reflection on your problem solutions. Please take up these opportunities, as they will help you learn and deepen your appreciation for the class content. Learning is a social activity, as is science. I look forward to learning together with you.

<u>Course units:</u>

1. Light rays
2. Light as a wave
3. Light sources
4. Color perception
5. Reflection
6. Refraction
7. Lenses

8. Camera and eye
9. Possible other topics such as lasers and holography

Learning Goals

At the end of this course, students should be able to:

1. **Appreciate the beauty** in optics, including the nature of light and the nature of vision and perception.
2. **Appreciate the role that physics plays** in deepening our understanding of the world, particularly in terms of optics.
3. **Cultivate and explore your own curiosity** about optical phenomena, including the ability to make observations, wonder about something, and propose further explorations to better understand it.
4. **Analyze a scientific argument:** Identify the claim that is being made, the evidence or data which supports it, and the reasoning (or "warrant") that connects the two.
5. **Generate a scientific argument:** Indicate the evidence or data which supports that claim, and the reasoning (or "warrant") that connects the data to the claim.
6. **Explain the physics** behind both everyday and unusual optical phenomena without relying on complicated mathematics.
7. **Predict, using words and/or numbers as appropriate, what will be observed** when given a particular situation (such as a light source, image formed by lenses, observing an object reflected in mirrors, the color that is perceived under certain situations).
8. **Make numerical predictions accurately:** Be able to identify the appropriate algebraic equation, re-arrange it to solve for the desired variable, and solve.
9. **Reflect on your work and learning in the course,** and help others to do the same – do you know what you are solving and why? Are you achieving the goals of the course? How do these ideas relate to your life or major? Are there areas where you need additional feedback or assistance to succeed?
10. **Apply principles used in the class** to your everyday life and/or your field of study.

Assessments to test achievement of learning goals

1. **Written work.** Can the student communicate clearly, including arguing a point using claims and evidence? Can the student communicate where they find beauty and utility in these ideas?
2. **Factual testing.** Can the student recognize and use key ideas in the course?
3. **Observation and noticing.** Can the student observe phenomena and identify relevant or interesting details? Can they notice aspects of phenomena that relate to the ideas of the class, making sense of "messy" observations by pulling out relevant details?
4. **Interpreting phenomena.** When giving a phenomena or situation, can the student explain what is going on using principles from the class? Can she choose the appropriate principle which relates to the situation? When given a situation, can the student predict what will be observed, using principles from the class?
5. **Questioning and testing** (i.e., experiments). When given a situation, can the student identify things that pique their curiosity, and devise things that they might test or try to understand it better?

6. Problem solving. Can the student make accurate numerical predictions, including choosing the appropriate equation and carrying it through? Can the student reflect on their own learning?
7. Peer feedback, including group review, group exams, peer instruction. Can the student give and receive feedback from peers to help one another reflect on their learning and help each other learn?

How To Do Well in This Course

Physics can be a difficult subject, but succeeding in this course does not have to be. Follow these suggestions and you will do well:

- Physics is about applying concepts. It is not just a collection of facts. Focus on understanding, *not* memorization. Focus on making sense of it, *not* getting the answer.
- Attend class, participate and ask questions.
- Work together – in class and on homework. Physics is not a solitary sport. (That said, if you find you are doing the whole assignment as a group, you're not getting enough independent practice; make sure to try the assignment on your own first).
- Practice solving many problems. This will help you recognize patterns and become a more effective problem solver.
- Start on your homework early and keep up with the assignments.
- Make use of the many resources available to you (TA, LA, online help)

Students begin this class with a range of backgrounds in physics and math. As a result, it is impossible for each class to be perfectly matched to everyone's background. We will work hard to provide whatever help is necessary for every student, regardless of their background, to do well in the course and achieve all of the learning goals. However, it is your responsibility to recognize if you need that help, and to take advantage of its availability, see below.

Resources for Assistance

- Help hours: The help room in Duane basement, G2B90, is staffed several times by the course staff, see full schedule above. Additionally, you can always stop into the Physics Help Room (G2B90), which is staffed by TAs from various courses.
- Discussion board: We will use the discussion feature on Canvas for out of class participation.
- Your classmates: Collaborative group work is an important part of this course. If you work well with someone, write down their name, and you can serve as resources for each other when working on assignments.

GRADING AND ASSIGNMENTS

You will notice that there are several different types of assignments, each due on the same day each week. I provide different types of assignments to provide different types of practice – mathematics, writing, drawing, connecting material to everyday life, working with others – all of which will count towards your final grade. I also provide different types of opportunities to show me what you know; that way, if you do poorly on a particular exam, you can still earn a good grade in the course. **All due dates can be seen on the course schedule on Canvas.**

YOUR FINAL GRADE

You will be graded based on your participation (in class and out of class), as well as your mastery of the learning goals of the course (primarily gauged through exams and homework). Note exams will have questions related to activities and group work done in class; if you do not come to class to see the demos and participate in the activities it will be very difficult to answer these exam questions. In the past, the average grade in this course has been about a B. Final grades will be assigned on an absolute scale according to your final point total: A/A- = 100 - 89%; B+/B/B- = 89 - 78%; C+/C/C- = 78 - 67%; D+/D/D- = 67 - 56%; F < 56%. These grade cuts may be lowered (i.e. 'made easier') but they will not be raised (made harder).

GRADING BREAKDOWN

Assignment	Due Date	% of Final Grade
Canvas Online Homework (roughly 12; lowest dropped)	Typically Wednesday at 11:59pm	15%
Canvas Written Homework (roughly 12; lowest dropped)	Typically Wednesday at 11:59pm	20%
Pre-lecture Assignments (roughly 12; lowest dropped)	Weekly on Tuesday at 10am	5%
Exams (3, equal weight)	Feb 15, Mar 21, TBD	45%
Final Project *Topic/groups due* *Progress report* *Final report*	 April *2* *April 16* *April 30*	10% total *1.5%* *2%* *6.5%*
Class participation (iClicker and in-class activity participation)		5%

HOMEWORK (35%)

Homework is exceedingly important for developing an understanding of the course material. I strongly encourage you to find some partners and work on the homework together. Essentially all scientists work as part of a group. However, it is important to be certain that you OWN the material by writing it up on your own. Otherwise, you will not truly understand the ideas, and will flounder on the next assignment,

or when it comes to the exam. If you feel that significant credit for 'breaking' a problem goes to one particular individual or reference work, feel free to reference the breakthrough and then press on.

There are two types of homework in this course: Canvas Online Homework (15%) and Canvas Written Homework 20%). Both types of homework are due Wednesday at 11:59pm. After 11:59pm on the due date, there will be a 1hr grace period to accommodate any technological issues with the submission after which point no further submissions will be accepted and there will be no extensions for the homework. Solutions will be posted Thursday mornings.

CANVAS ONLINE HOMEWORK (15%)

Canvas online homework will involve multiple-choice questions and numerical calculations. No grace will be given for lost internet connections or malfunctioning computers, so plan to complete your assignments early! The lowest homework score will be dropped. Failing to turn in more than one homework will have a negative impact on your grade.

CANVAS WRITTEN HOMEWORK (20%)

In addition to the multiple-choice homework, a small assignment will be due every week which will give you practice in sketching, explaining or taking photographs, and noticing the world around you. These assignments will be a mixture of simple and fun, and more challenging. The lowest will be dropped. Canvas written homework is typically due on Wednesday by 11:59pm as an upload to Canvas.

PRE-LECTURE ASSIGNMENTS (5%)

Every Tuesday, there will be a pre-lecture assignment due which prompts you to think reflectively about the reading assignment, remind yourself of things you may not have thought about in a while, and to prepare for class. Assignments are graded for thought and effort, and rarely for correctness. The pre-lecture assignments will also prompt you to take a picture of something in your everyday life that relates to the physics we are learning. These must be photos taken by YOU, not found on the internet or taken by someone else. Put some thought into these photos as you will be required to use them as part of your final project. Pre-lecture assignments are due on Tuesday, at 10 am.

EXAMS (45%, EQUALLY DISTRIBUTED ACROSS 3 EXAMS)

Be sure to be in class on exam days! It is your responsibility to make sure that you have no conflicts. ***There is no mechanism for making up exams***. The only exception is for religious obligations, with notification in the first two weeks of class, and medical emergencies, at my discretion. Students with a documented disability will be given extra time on exams and will take the exam in an alternative room. Please contact me if you are requesting this accommodation.

There will be two midterms and a final. The final will be cumulative, but will preferentially cover material in the last portion of the course. Note exams will have questions related to activities and group work done in class; if you do not come to class to see the demos and participate in the activities it will be very difficult to answer these exam questions.

Each exam will be done in a two-stage format, where you complete the exam individually, and then in groups. I believe that this structure is more appropriate for an interactive class like this one, because you can continue to learn from each other even on the assessments. Exams will take place as follows:

1. Students complete exam individually (~45 minutes for the two midterms). This portion is worth 85% of the exam grade.
2. Students turn in the individual exam, and form groups. Every group receives a new copy of the exam to complete as a group.
3. In groups, students come to consensus on the answers on the group exam (~20 minutes). This portion is worth about 15% of the exam grade. If the individual score is greater than the exam score, then the group exam will not count towards the individual grade (i.e., the group portion can only help your grade, not hurt it).

Final Project (10%)

You will be doing a group project as part of your final grade in the class – this is intended to be a fun way to express some creativity and connect science and art. In essence, the project allows me to reduce the overall weight of the exams, and for you to have more direct control over a portion of your grade. I recommend you work in groups of 2-3; the larger the group, the higher the expectations will be of the scope of the final project. Note that your chosen project, and the people in your group, are due four weeks in advance of the actual project. You may create your own project idea, or choose from a list of examples provided. If you have an idea and are looking for a group, post it on the Discussion board on Canvas to find a team. For example, a group might form around a common interest (e.g., photography, theater, or art), or create a diverse team to connect differing media. Full description of the project, and a rubric will be given later.

Class Participation (5%)

I really value participation, and have planned a variety of interesting and useful activities in class. Don't hide in the back. Plan to come to class each day and participate – you'll learn more, and class will be more fun. In class participation will be through in-class activities and worksheets, clicker questions, and class discussions. Lecture recordings and slides will be posted to the Calendar on Canvas for you to reference outside of class.

> **Clicker questions.** We will use clickers to enable engagement with the material. Discussion with your peers around the questions is expected, because this will help you (and others) learn. Be a team player, and both listen and contribute to these discussions. Clickers count towards class participation, with 3 "free clicker days" that are not counted. Clicker questions will be graded for participation only. There is no penalty for getting a clicker question wrong; the questions are meant to help you learn, not to test you. If I begin to feel that students are not honestly engaging in the clicker questions, I can choose to begin counting them for correctness, but I will warn you if that is the case.

The Canvas Discussion Forums. Discussion forums provide a place where you can spontaneously ask questions, share photos, videos, insights, or questions with classmates. Posting and discussing will give you a chance to solidify and deepen your learning. Participation in the discussion forums is not required and will not be graded; however, these forums are a resource for getting help and engaging in the class content. I highly encourage you to use them. Note, the discussion forums are monitored by the instructor and TA; posting inappropriate content (e.g., answers to homework questions) will not be tolerated.

GRADING POLICIES

Late Work: There are no extensions for homework, and no make-up exams. If you have extenuating circumstances (outside your control), come talk to me and we will discuss options. I cannot help you if I do not know there is a problem. The sooner you let me know, the more options there will be; after the fact there is often little I can do without documentation of a significant emergency.

Plagiarism and Academic Dishonesty: All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://honorcode.colorado.edu

Turnitin.com: To check for plagiarism (i.e., using someone else's words in your own work), we will use Turnitin on the final project. I will be able to see if you have lifted explanations from websites or other work, so don't risk it.

USING CANVAS

Most of the activities in this course take place within the university's Canvas learning management system. Use your personal Identikey and password to access your Canvas Home site by visiting canvas.colorado.edu. From there, select our course name to access our course Canvas site.

CLASSROOM BEHAVIOR

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability,

creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy.

For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Requirements for Infectious Diseases

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the further guidance of the Public Health Office. For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

Accommodation for Disabilities

Disability Services determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation, please let me know as soon as possible via email. Also, see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and the support resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.

See the campus policy regarding religious observances for full details.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students