PHYS 153: Physics of Light, Color, and Vision (CRN: 32964) Spring Term 2022
Syllabus
(updated 30 March 2022, subject to change)

Instructors:

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Teaching Assistants

Valerie Beale, vbeale@uoregon.edu
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Drop-In: Th 10:00-11:00

Austin Batz, abatz@uoregon.edu
Office: W 10:00-11:00
Drop-In: M 15:00-16:00

Meeting times and location:

Lectures: Tu, Th 10:00-11:50, 100 Willamette Hall
Credits: 4
Communication: The best form of communication between students and the teaching team will be via email. You must use your uoregon.edu email address. Please mention PHYS 153 in the subject line.

Every week I will post an announcement on Canvas that previews exciting, critical concepts we’ll work on that week and a checklist of the week’s due dates.

Office Hours and Questions:
I will host office hours each week on Monday 13:00-14:00. I welcome meetings outside my regular office hours, too. Just email me to set a time.

If you contact me with a question, I will try to respond within one business day. We will typically provide feedback on assignments within one week.

Why should you reach out to me?
Talking with students about the course material is a true pleasure—confused or excited about something? Wondering how what we’re learning relates to current events, career choices, or other classes you can take? Please be in touch! Having troubling with some aspect of the course? I would like to strategize with you and I will do everything I can to help you succeed.

Course Synopsis:

Light has a profound impact on our daily lives both directly and indirectly. This course will explore the physics of light and explain how its basic properties produce a diverse range of effects in technology and nature. The course is concept driven and requires a minimum of mathematics (algebra – we will cover a bit of trigonometry at the end – though it is not crucial).
The course will begin with an introduction to science and how scientists think and view the world. We will then have a basic introduction to waves. We move on to the description of light as an electromagnetic wave. Light is part of a larger family of the electromagnetic spectrum, which spans through gamma rays, X-rays, ultraviolet radiation, light, infra-red radiation, microwaves and radio waves, which we discuss next. The manner in which these various forms of radiation interact with the world will be compared and contrasted. This leads to the discussion of color and how different objects display different colors. Two key properties of light – reflection and refraction of light – are then discussed. We show how these are used to create images and how mirrors and lenses can be used to magnify objects. This leads us to human vision and a (physicist’s) description of the eye, common vision errors and ways we correct these (e.g. glasses). We then turn to more advanced topics of polarization and the wave properties of light – particularly diffraction and interference. The course concludes with a discussion of light sources and their properties.

Course learning objectives:

- Explain in simple terms what science is and how it is performed
- Discuss how science fits within the broader realm of human activities
- Define facts, laws and theories and highlight their key differences
- Discuss what physics is as a science (the study of what?) and how it relates to other sciences and technology
- Describe science as measurements, precision, and model building (quantitative predictions)
- Use dimensional analysis and units to confirm simple solutions to physical problems
- Discuss basic properties of waves (amplitude, wavelength, frequency, velocity) and calculate simple relationships between velocity, wavelength and frequency of waves
- Describe the physical basis for light and its properties: Light is an electromagnetic wave
- Explain how light is scattered by matter (atoms and molecules)
- Explain how the material properties of transparency and opaqueness arise from light interacting with matter
- Explain how color arises from objects by emission, absorption or reflection
- Describe color mixing for both additive and subtractive colors
- Explain how color from arises from light scattering (e.g. a blue sky or red sunset)
- Discuss how the propagation of light can be describe by rays, which gives rise to shadows
- Discuss how the principle of least time leads to the laws of reflection
- Discuss the differences between diffuse and specular reflection
- Explain how reflection from curved surfaces can lead to magnification
- Describe the basic operation of a reflecting telescope
- Discuss the origins of various optical illusions due to reflection
- Explain refraction of light and its physical origin
- Discuss the origins of various optical illusions due to refraction
• Explain spectral dispersion of materials and how this affects the refraction of light leading to rainbows
• Discuss the origins of total internal reflection
• Explain how an image is formed by a pinhole camera
• Describe the basic properties of converging and diverging lenses and how they can be used to form images
• Give simple descriptions of common lens defects and imaging distortions
• Identify basic lenses that occur in nature
• Describe the structure of the human eye, image formation and common vision error
• Discuss how the retina converts light into an electro-chemical signal that is processed by the brain
• Explain how the nervous system processes optical signals
• Explain how wave propagation can be modeled with Huygen's construction
• Describe the diffraction of waves and how this leads to limited resolution for imaging
• Describe superposition and interference of waves including double slit interference
• Explain how a diffraction grating separates white light into colors at different angles
• Discuss how thin film interference results in different reflectivity for differing wavelengths
• Explain the polarization of light and how unpolarized light can be polarized upon reflection
• Discuss basic atomic structure and how this leads to absorption and emission spectra of light
• Describe simple types of light sources and their properties: incandescent, florescent, phosphorescent and bioluminescent light, lamps, lasers

Course learning activities

Learning is an active process and the main learning activities for the course are
1) Attending lectures and participation in ‘in-class’ quizzes (clicker questions)
2) Reviewing lecture slides
3) Completing homework assignments
4) Participation in office hours and small group discussions

If you have questions or are unsure of material, you should seek assistance by sending an email to the instruction team. It is your responsibility to ask questions and seek clarification, direction and guidance to any assignments – we do not know what you do not ask.

Course resources

Canvas will be used in this course as an online resource for the syllabus, course materials, assignments, quizzes and exams. Please frequently check Canvas to stay up to date on the course materials that are posted. Important announcements will also be sent via email, so it is best to get into the habit of checking your email daily.

Textbook: There is no required textbook for the course. However, you may find Conceptual Physics by Paul Hewitt (Pearson) as a very resource for the course.
Course assessment:

Assessment of student learning will be based on participation in engagement activities (in-class activities), homework assignments, and two exams. The relative weights will be as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement activities</td>
<td>(20%)</td>
</tr>
<tr>
<td>Homework assignments</td>
<td>(40%)</td>
</tr>
<tr>
<td>Exams</td>
<td>(30%)</td>
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</tbody>
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Due Thursday at 5:00pm

Thursday 28 April and 2 June

**NOTE:** One examination occurs during dead week.

**Grading Scale:** The expected grading scale for this course is

100-90 = A, 90-80 = B, 80-70 = C, 70-60 = D, <60 F. If necessary, a curve may be applied to achieve a higher average final grade. However, you are guaranteed at least the grade listed here based on your course average. Pass/fail grading option: A passing grade requires at least the equivalent of a C− grade.

**Late work policy:** Late work (homework, discussion board posts, etc.) will only be accepted no more than 24 hours after the deadline with a 20% penalty. Partial work may be turned in on time, and only the late portion will be penalized. An email should be sent to both the instructor and the GE's to notify that late work has been submitted. Work may be turned in late with no penalty only under extenuating circumstances, preferably by pre-arrangement with at least 24-hours notice before the normal deadline.

**Expectations**

**Course participation:** Learning is an active process that requires student engagement with the course materials. If you have questions or are unsure of material, please ask! You can also seek assistance by email and/or during office hours.

**Lectures:** The primary resource for the term will be the lectures and activities during lectures. Thus, it is extremely important to attend all lectures.

**Course reading:** Supplementary reading from *Conceptual Physics* by Paul Hewitt is given in the course schedule below.

**Course feedback:** If you have suggestions for improving anything about how the course is going, please drop the instructor a note.

**Academic honesty:** Students have the responsibility to behave honorably in an academic environment. The University Student Conduct Code ([http://dos.uoregon.edu/conduct](http://dos.uoregon.edu/conduct)) defines academic misconduct. Academic dishonesty, including cheating, fabrication, facilitating academic dishonesty, and plagiarism, devalues the reputation of our institution, its faculty, its students, and the degrees we offer. Moreover, academic misconduct is particularly unfair for the students who do their work with integrity and honor. All incidences of suspected academic misconduct will be reported to the Office of Student Conduct and Community Standards. The procedures for handling academic misconduct cases are outlined in Oregon Administrative Rule OAR517-021-0215.

**Creating an inclusive learning environment:** Students are expected to conduct themselves in a manner that contributes to a positive learning environment for all within the classroom.
Accessible Education: The University of Oregon is working to create inclusive learning environments. Please notify us if aspects of the instruction or course design result in barriers to your participation. You are also encouraged to contact Accessible Education Center in 164 Oregon Hall at 346-1155.

If you have a documented need for accommodations in this course, please meet with the instructor in the first week of term so that we can design a plan for you. Also please request that the Accessible Education Center (AEC) send a letter verifying your documented needs for accommodations. [http://aec.uoregon.edu](http://aec.uoregon.edu) If you have a disability, but have not registered with AEC, you should contact them as soon as possible. It is more likely that adequate special accommodation can be made if organized through AEC.

General Guidelines for Class Participation

1. **Participate and Contribute:** Students are expected to participate by sharing ideas and contributing to the collective learning environment. This entails preparing, following instructions, and engaging respectfully and thoughtfully with others. More specific participation guidelines and criteria for contributions will be provided for each specific activity.

2. **Interact Professionally:** Our learning environment provides an opportunity to practice being professional and rigorous in our contributions. As much as possible, use correct spelling, grammar, and style for academic and professional work. Use discussions and activities as opportunities to practice the kind and quality of work expected for assignments. Moreover, seize the chance to learn from others and develop your interpersonal skills, such as mindful listening and awareness of one’s own tendencies (e.g. Do I contribute too much? Too little?).

3. **Expect and Respect Diversity:** All classes at the University of Oregon welcome and respect diverse experiences, perspectives, and approaches. What is not welcome are behaviors or contributions that undermine, demean, or marginalize others based on race, ethnicity, gender, sex, age, sexual orientation, religion, ability, or socioeconomic status. We will value differences and communicate disagreements with respect. We may establish more specific guidelines and protocols to ensure inclusion and equity for all members of our learning community.

4. **Help Everyone Learn:** Our goal is to learn together by learning from one another. As we move forward learning during this challenging time, it is important that we work together and build on our strengths. Not everyone is savvy in remote learning, including your instructor, and this means we need to be patient with each other, identify ways we can assist others, and be open-minded to receiving help and advice from others. No one should hesitate to contact me to ask for assistance or offer suggestions that might help us learn better.
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lectures</th>
<th>Activities</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29, 31 Mar 2022</td>
<td>Intro and orientation, Science as a human activity, physics, and optics (study of light), mathematics, measurements, precision, accuracy. Waves</td>
<td>1) Getting to know you survey</td>
<td>Ch. 1, 19</td>
</tr>
<tr>
<td>2</td>
<td>5, 7 Apr 2022</td>
<td>Light properties: EM waves, velocity, spectrum (frequency and wavelength). Interaction of light and matter (opaque and transparent materials)</td>
<td>1) HW 1: Science, Intro to Waves – due Th 7 Apr</td>
<td>Ch. 26</td>
</tr>
<tr>
<td>3</td>
<td>12, 14 Apr 2022</td>
<td>Color, color mixing, light scattering</td>
<td>1) HW 2 EM waves – due Th 14 Apr</td>
<td>Ch. 27</td>
</tr>
<tr>
<td>4</td>
<td>19, 21 Apr 2022</td>
<td>Light rays, shadows, principle of least time, reflection</td>
<td>1) HW 3 Color – due 21 Apr</td>
<td>Ch. 27, 28</td>
</tr>
<tr>
<td>5</td>
<td>26, 28 Apr 2022</td>
<td>Refraction and its physical origin, optical illusions from diffraction</td>
<td>1) Exam 1 – Th 28 Apr</td>
<td>Ch. 28</td>
</tr>
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<td>6</td>
<td>3, 5 May 2022</td>
<td>Dispersion, rainbows, total-internal reflection, pinhole camera, converging and diverging lenses, lens defects and image distortions, lenses in nature</td>
<td>1) HW 4 Reflection and refraction – due Th 5 May</td>
<td>Ch. 28</td>
</tr>
<tr>
<td>7</td>
<td>10, 12 May 2022</td>
<td>Human eye structure, image formation, vision errors, retinal response, nervous system</td>
<td>1) HW 5 Lenses and imaging – due Th 12 May</td>
<td>Ch. 26, 28, Falk handouts</td>
</tr>
<tr>
<td>8</td>
<td>17, 19 May 2022</td>
<td>Wave motion, Huygen’s construction, diffraction, image resolution, superposition and interference, double slit interference, diffraction grating, light polarization</td>
<td>1) HW 6 Vision – due Th 19 May</td>
<td>Ch. 29</td>
</tr>
<tr>
<td>9</td>
<td>24, 26 May 2022</td>
<td>Atomic structure, absorption and emission spectra, light sources (incandescent, fluorescent, phosphorescent, bioluminescent), lamps, lasers</td>
<td>1) HW 7 Light sources due Th 26 May</td>
<td>Ch. 30</td>
</tr>
<tr>
<td>10</td>
<td>31 May, 2 Jun 2022</td>
<td>Revision and catch up</td>
<td>1) Exam 2 – Th 2 Jun</td>
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**Other important dates:**
- Last day to drop without a W: 2 April 2022
- Last day to register: 4 April 2022
- Last day to withdraw: 15 May 2022