

# **OPTI 100H: What is Light?**

## **Course Goal**

Introduce you to the fascinating field of optics and how it so important in our daily lives, how it leads to new technologies, learn about the broad and extensive careers, and how to explain and analyze light.

## **Prerequisites**

None

## **Overview**

Light is an important aspect of our daily lives, from the lights that we use to see, to the displays that give us information and entertainment, to lasers that are used in optical fibers to transfer information from one place to another – optics is around us everywhere. This course will delve into what light is by presenting the technology, phenomena, and systems that we use on a daily basis. It starts with our eyes used to view our smartphone or computer displays. The information for these displays is often provided via optical networks, which in the long haul sector use fiber optics, lasers, and other optical subsystems. Along the way we will discuss the three interpretations of light: as a ray (geometrical), as a wave (physical), and as both - known as the wave-particle duality (quantum).

## **Number of Units/component**

The class is three units and comprised of lecture (50% workload); and discussions, tours, and labs (50%).

## **Locations and Times:**

TR 2.00 pm – 3.15 pm Meinel 432

## **Instructor Information**

John Koshel: Meinel 403A, Academic Programs office, 621-6357

Open / by appointment (most individuals in the AP Office (Meinel 403) can access my schedule)

- Available via Zoom at <https://arizona.zoom.us/my/koshel>,
- I get an email when you enter my Zoom room – wait a couple minutes to see if I can get there, and
- If not, I will email you back about availability (you must have your name / recognizing ID within Zoom).

## **Expected Learning Outcomes**

1. Demonstrate an understanding of how light through technology, phenomena, and systems are a part of our daily lives, which is done through discussion, laboratories, problem solving, & so forth (Student Outcome 2).
2. Demonstrate an understanding of the three interpretations of light (geometrical, physical, and quantum) through discussion, solving problems, and so forth (Student Outcome 1).
3. Conduct simple experiments to be able to manipulate, measure, and use light (Student Outcome 3).
4. Learn technical communication via papers, videos, and presentations (Student Outcome 6).

## **Required Texts**

- Required: none; course notes will be provided.
- Recommended: [SPIE Field Guides](#); books that are freely accessible online through UA Libraries.

## **Topics and/or general calendar**

Week 1: Introduction to light: description, properties, ...

Lab/Field Trip: Optics kits lab and pinhole camera experiments, and optics in nature around us

Discussion: Introduction, optics around us, in particular sources and spectrum

### **LIGHT IS A RAY**

Week 2: Start the light journey – looking at your Smartphone, computer, tablet – Intro to the human eye

Lab/Field Trip: Cow eye dissection experiment, Optics Museum

Discussion: Components of the eye

Week 3: Displays – follow the rays (geometrical optics) back into the phone

Lab/Field Trip: VR/AR Displays Lab, Pepper's Ghost, "cinema" experiments, and VR experiments

Discussion: Components of displays

Week 4: Smartphones – the optical systems in your phone – how are they made

Lab/Field Trip: Cleanroom

Discussion: Look into a cell phone, lithography

Week 5: Light as a ray – how do we design these optical systems?

Lab/Field Trip: Optical design Labs, Optical Fabrication course

Discussion: Intro to optical design and analysis software

Week 6: The nitty gritty of optical design

Lab/Field Trip: LOFT, AOL, maybe even a visit to a local company

Discussion: Use of optical design and analysis software

Week 7: Forming the image – detectors and color

Lab/Field Trip: Aerospace Imaging Labs, Infrared Imaging Lab, color experiment

Discussion: Teaching labs – working with detectors

### **LIGHT IS A WAVE**

Week 8: Lasers – sources powering the internet

Lab/Field Trip: Lasers, spatial filtering lab

Discussion: Properties of a laser, total internal reflection

Week 9: The internet is made up by optical fibers

Lab/Field Trip: Fiber Labs, coupling into a fiber experiment

Discussion: Fiber-optic discussion

Week 10: Optical switches, steering light

Lab/Field Trip: Polarization Lab, polarization experiment

Discussion: Polarization – what the heck is it?

Week 11: Interference and diffraction

Lab/Field Trip: Interferometry and diffraction experiments, Lightweight Optics lab

Discussion: Interferometers and optical metrology

Week 12: Novel optics technology

Lab/Field Trip: Medical Imaging Labs, maybe a visit with local industry

Discussion: State-of-the art systems

## **LIGHT IS BOTH**

Week 13: Quantum optics

Lab/Field Trip: Quantum Labs, Material Labs

Discussion: What does all of this mean...

Week 14: Quantum Information/Engineering

Lab/Field Trip: Quantum Engineering Labs, Ultrafast Technology Labs

Discussion: Quantum engineering, state-of-the-art technology

## **COURSE WRAP UP**

Week 15: Course wrap up and presentations

Lab/Field Trip: Mirror Lab

Discussion: Astronomical/space optics

NOTE: this schedule is draft. Tours and the like depend on lab availability, so the schedule will be updated to accommodate if and when we can get into a certain lab.

## **Major Course Assignments and Due Dates**

- No exams,
- One short paper in each section (geometrical, physical, and quantum optics interpretations),
  - NOTE: rather than a paper, for ONE of the three you do a 5-minute class presentation
- One course paper and video based on one of the labs/groups in the College,
- Video presentation(s), and
- Unless indicated, assignments are due on Fridays, at 11.59 PM.

## **Course Policies**

### **Grading Policy**

All handed-in materials are due in D2L by 11.59 pm on the stated dates:

Optics Museum video (#3)	10%	4-5 minute video	Friday, 6 February
Light is a Ray paper (#7)	10%	3+ page paper	Friday, 6 March
Light is a Wave paper (#11)	10%	3+ page paper	Friday, 10 April
Light is Both paper (#14)	10%	3+ page paper	Friday, 1 May
Lab review paper/video (#15)	20%	5 minutes/6+ pages	Friday, 9 May
Other assignments (10)	30%	As required	Fridays, as indicated
<u>Discussion board/class participation</u>	<u>10%</u>	<u>As required</u>	<u>throughout course</u>
Total	100%		

The grade will be determined according to the cumulative percentage earned such that 90-100% = A, 80-89% = B, 70-79% = C, 60-69% = D, below 60% = E.

### **University-Wide Policies**

Links to the following UA policies are provided here, <http://catalog.arizona.edu/syllabus-policies>:

- Absence and Class Participation Policies,
- Threatening Behavior Policy,
- Accessibility and Accommodations Policy,
- Code of Academic Integrity,
- Nondiscrimination and Anti-Harassment Policy, and
- Subject to Change Statement.

### **Other policies**

- Confidentiality: <http://www.registrar.arizona.edu/ferpa>.
- Safety: For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): <https://cirt.arizona.edu/case-emergency/overview>.
- Safety video: <https://uapd.arizona.edu/community-engagement/active-shooter-video>.
- Classroom Behavior: To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

## **Additional resources**

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>.

### **Campus Health**

<http://www.health.arizona.edu/>

Campus Health provides quality medical and mental health care services through virtual and in-person care.

Phone: 520-621-9202

### **Counseling and Psych Services (CAPS)**

<https://health.arizona.edu/counseling-psych-services>

CAPS provides mental health care, including short-term counseling services.

Phone: 520-621-3334

### **The Dean of Students Office's Student Assistance Program**

<https://deanofstudents.arizona.edu/support/student-assistance>

Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow up services.

Email: [DOS-deanofstudents@arizona.edu](mailto:DOS-deanofstudents@arizona.edu)

Phone: 520-621-7057

### **Survivor Advocacy Program**

<https://survivoradvocacy.arizona.edu/>

The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.

Email: [survivoradvocacy@arizona.edu](mailto:survivoradvocacy@arizona.edu)

Phone: 520-621-5767