OPTI 306 – Radiometry, Sources, & Detectors

OPTI 306 - Radiometry, Sources and Detectors - Fall, 2021. Radiometric concepts, symbols, units and nomenclature. Radiative transport in free space and through optical systems. Effect of material properties on radiative transport. Blackbodies and other radiation sources. Fundamentals of radiation detectors, including principles of operation, noise and figures of merit. Illustrative imaging and nonimaging radiometric systems.

Prerequisites: OPTI211R; concurrent in OPTI 380A or (ECE 217, ECE 221, OPTI 360, or OPTI 380B)

Class time: MW, 2.00 pm – 3.15 pm in Meinel 307
Instructor: John Koshel
Email: jkoshel@optics.arizona.edu
Office: Meinel Room 403A
Phone: 621-6357
Office Hours: In person or https://arizona.zoom.us/my/koshel – come anytime or schedule – I get an email when you go into the Zoom room if I am not there

TA: Zheng Zhang
Email: zhengz1@email.arizona.edu
Office: 8th floor common area
Office Hours: MW, 3.30 pm – 4.30 pm

Course Objectives:
This course covers the generation (sources and radiometry), propagation (radiometry), and measurement (detectors and radiometry) of optical radiation. The theory, units, approximations, instrumentation, and applications will be presented in detail.

Learning Outcomes:
1. Understand how to measure optical radiation with physical (radiometric) and psychophysical (photometric) terms,
2. Understand the concept of étendue,
3. Know the types of sources, especially blackbody ones,
4. Know the various type of detectors, and
5. Be able to calculate noise and SNR arising from measurement.

Course Material and Logistics:
Lectures: PDFs will be uploaded to D2L around each lecture time. Note that not all material will be within the PDFs: supplement the lectures with class notes. All lectures will be live online (Zoom) and a recording will be posted to D2L.
Recitation: There are no scheduled recitations at this time, but they may be setup as required. Homework, solutions, midterm, labs, and so forth will be discussed at any such meetings. Attendance at any recitation is optional.
Homework: Assignments and solutions will be uploaded to D2L. Assignments may involve lab kits that will be supplied at a later date.
Other: Other material will be posted on D2L as warranted
Absence: You are expected to follow the UA Policy, but you are adults so I respect your decisions. I follow UA policies for religious beliefs and pre-approved absences. See end of document.

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.
Course Outline (75-minute lectures)
This listing is tentative, and the order and topics may change as the semester progresses.

<table>
<thead>
<tr>
<th>Lecture Number</th>
<th>Expected Date</th>
<th>Topic(s)</th>
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<tbody>
<tr>
<td>1</td>
<td>8/23/21</td>
<td>Syllabus, My Field, What is Radiometry, and Units</td>
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<td>2</td>
<td>8/25/21</td>
<td>Projections and Radiance</td>
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<td>Power and Intensity</td>
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<td>8</td>
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<td>Radiative Transfer I</td>
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<td>Configuration Factor</td>
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<td>11</td>
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<td>Integrating Sphere</td>
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<td>Blackbody radiation: Planck’s Law</td>
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<td>31</td>
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See links for Academic Dates: [Undergraduate](#)

Note that the radiometry material is used throughout the lectures that follow the first course section. It is imperative that you understand the first “twelve” lectures in order to fully understand the following lectures that follow.

**Texts (recommended) – see D2L > Library Tools for easy access to some:**

   a. GET THIS ONE!
   b. You can get it for free through SPIE since the UA has a site license – look at D2L > Library Tools – should be accessible on and off campus
   c. Off campus & (b) does not work, login with [VPN to the UA](#) (requires [UA NetID+](#))
   d. Go to the [SPIE website](#) and download

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   a. GET THIS ONE too!
   b. Great book IMO, but the notation is different than #1
   a. Another good book written by individuals with a connection to OpSci
   a. See chapters on radiometry, illumination, photometry, sources, etc.
   a. See #1 then visit the SPIE website and download
   a. See #1 then visit the SPIE website and download
   b. Illumination is based on the field of radiometry

Exams: There will be two exams – in class or take home (TBD).

Design Project: You will be asked to design a detection system at the end of the course. Included in the project will be the specification of the source, optics, and detector along with an analysis of the expected performance. The details of this project will be provided by early November.

Assignments: After most class lectures a “quiz” will be assigned. These quizzes will include questions from that day’s material, surveys, interpretations of material, case studies, and so forth. Each quiz will be due at the end of the day of the next class. Note that for some quizzes there “will be no right answer,” so completing them is a necessity to get 100% on those. The lowest three are dropped. Expect around 20 quizzes.

Homework assignments will be given, and they may involve computer simulations or physical measurements with apparatus to be supplied. Students are encouraged to work together on homework assignments, but the final write-ups must be independent. Homework is to be turned in by the end of the day it is due. Expect 4-6 homework assignments.

Grading: Assignments 20% (1 day late -25%, 2 days late -50%, no credit later)
Exam I 20% (in class or take home, around 13 October 2021)
Exam II 20% (in class or take home, around 17 November 2021)
Project 35% (due end of day of typical final, 10 December 2021)
Upgrade 5% (improve a lecture, assignment, etc.)

Grading: 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.

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For Undergraduates:
A: Excellent – has demonstrated a more than acceptable understanding of the material; exceptional performance; greatly exceeds expectations
B: Good – has demonstrated an acceptable understanding of the material; good performance; meets or exceeds expectations
C: Average – has demonstrated a barely acceptable understanding of the material; adequate performance; meets minimum expectations
D: Poor – has not demonstrated an acceptable understanding of the material; inadequate performance; does not meet expectations
E: Failure – little to no demonstrated understanding of the material; exceptionally weak performance

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.).

THREATENING BEHAVIOR

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

ACADEMIC INTEGRITY

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor’s express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

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Nondiscrimination and Anti-Harassment

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy.

Accessibility and Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Special Notes

- Classroom attendance:
  - If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
  - Notify your instructor(s) if you will be missing a course meeting or an assignment deadline.
  - Non-attendance for any reason does not guarantee an automatic extension of due date or rescheduling of examinations/assessments.
  - Please communicate and coordinate any request directly with your instructor.
  - If you must miss the equivalent of more than one week of class, you should contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
  - Voluntary, free, and convenient COVID-19 testing is available for students on Main Campus.
  - COVID-19 vaccine is available for all students at Campus Health.
  - Visit the UArizona COVID-19 page for regular updates.

- Academic advising: If you have questions about your academic progress this semester, please reach out to your academic advisor (https://advising.arizona.edu/advisors/major). Contact the Advising Resource Center (https://advising.arizona.edu/) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@.arizona.edu

- Life challenges: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.

- Physical and mental-health challenges: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

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