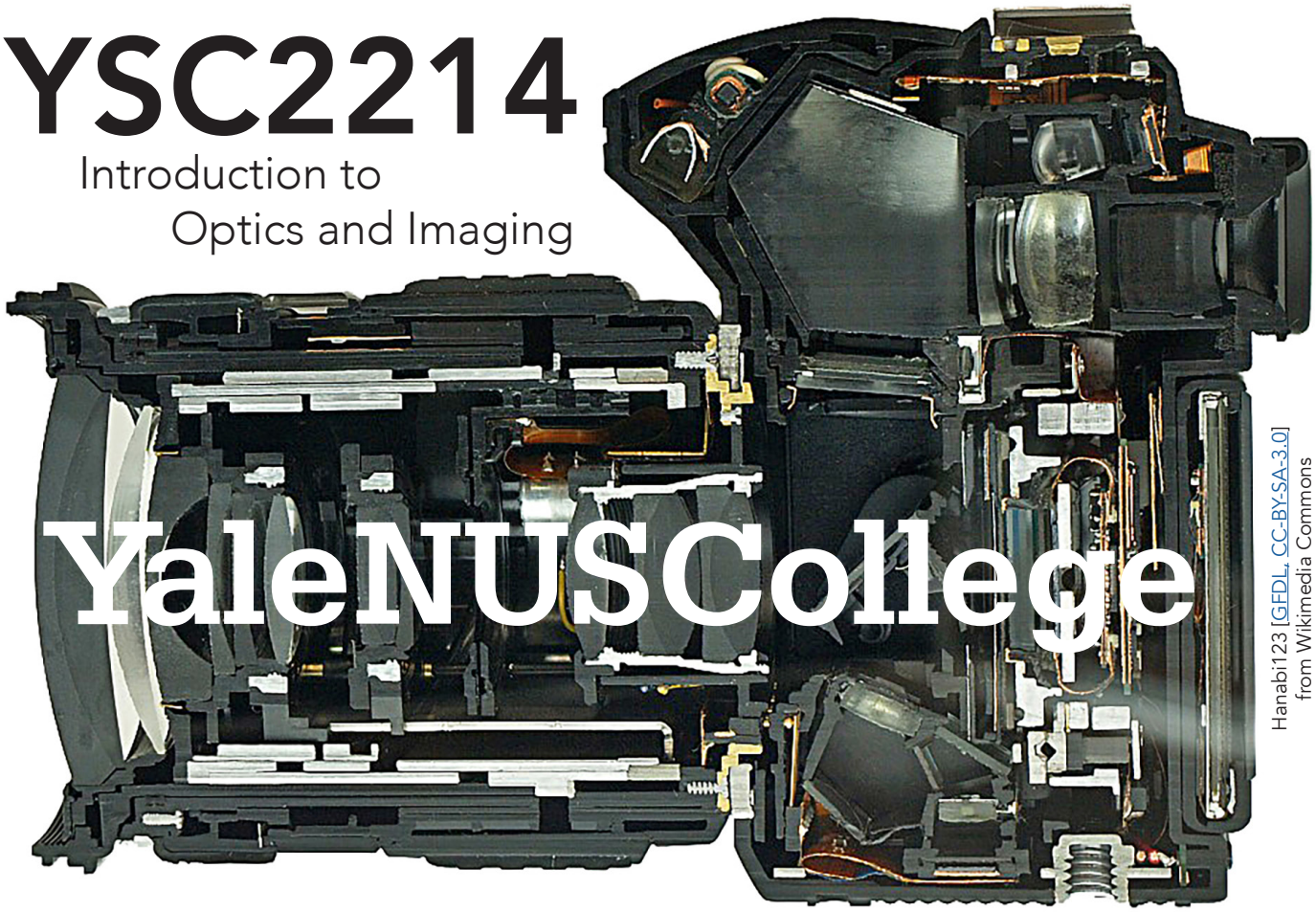
YSC2214

Introduction to Optics and Imaging



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Semester 2, 2018/2019
10:30-11:50 Wed & Thu in Classroom 11
10:30-11:50 Fri in Lab 1 on even weeks
Instructor: Asst. Prof. Ben Andrew Olsen
Email: ben.olsen@yale-nus.edu.sg
Office: RC1-02-06A (Saga, 2nd floor)

Course Description

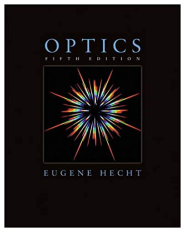
How do we see? What happens when we take pictures? Through the lenses of theory, computation, and experiment, this course will explore the foundations of optics and imaging. Students will learn how light travels, how it can be manipulated, and how it is used to make visual sense of the world. Students will learn about geometrical optics, wave optics, polarization, interference, and diffraction. Students will also be introduced to modern applications of optics that have had a significant impact on our lives such as lasers and optical communication.

Intended Learning Outcomes

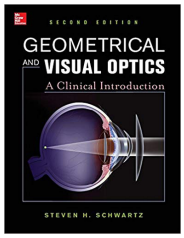
- Analyze systems of lenses, prisms, and mirrors using matrix analysis
- Compute the intensity and polarization patterns of focused beams of light
- Evaluate optical lens/telescope designs based on their diffraction limits and aberrations
- Design and construct optical systems using geometric and polarization optics, waveguides, nonlinear materials, and lasers
- Compare various digital and analog imaging technologies
- Explain common human vision disorders and their clinical treatments or corrections

Required and supplementary texts

Required:
Optics, 5th Edition
(Eugene Hecht)
ISBN: 978-0133977226
This is one of the standard optics texts, and can be useful as a reference.



Supplementary:
Geometrical and Visual Optics: A Clinical Introduction, 2nd Edition
(Steven H Schwartz)
ISBN: 978-0071790826



This book is a medical practitioner's text for the optics of human vision. Though it has much more detail than this course will cover, it is a useful guide to different vocabulary used in the medical field.

Assessment & Grading

American Letter System (no curve)

A+	100% to 97%
A	< 97% to 93%
A-	< 93% to 90%
B+	< 90% to 87%
B	< 87% to 83%
B-	< 83% to 80%
C+	< 80% to 77%
C	< 77% to 71%
D+	< 71% to 67%
D	< 67% to 60%
F	< 60% to 0%

Problem Sets	39%
Reading Exercises	1%
Lab Reports	18%
Lab Prep Exercises	2%
Midterm Exam	20%
Final Exam OR Project	20%

Problem Sets:
There will be a problem set assigned for each week of class. Problem sets are due at 18:00 the following Tuesday. Solutions will be marked for correctness; show your reasoning. Students are encouraged to work together after attempting problems on their own, and each student must submit their own work. The lowest problem set score will be dropped.

Reading Exercises:
The readings for each week will be accompanied by a short exercise including reading comprehension and a prompt to ask clarifying questions. Reading exercises are due at the beginning of class on Wednesday (or Thursday in case of a holiday). These exercises will be marked for completion only, and responses will be used to guide modifications to class content and pacing.

Lab Reports:
Laboratory work will be marked based on a combination of preparatory readings and questions (due at the beginning of lab sessions), proper etiquette while in the lab, and written reports due at 18:00 the following Friday (reports for Lab 3 are due Mar 8). Since time in the lab is very limited, preparation is critical, and readings & questions will be marked individually. In the lab, students will work in small groups to perform experiments and collect data. They will submit reports and recieve marks on the report as a group.

Midterm Exam:
The midterm exam will be composed of a combination of theoretical, computational, and experimental problems. Students will be provided with an equation sheet based on the midterm review session. The problems will be very similar to problem sets and lab activities, so it will be beneficial to review those solutions and be able to reproduce them without notes.

During the semester, the class will vote to decide between a final exam and a whole-class collaborative final creative project.

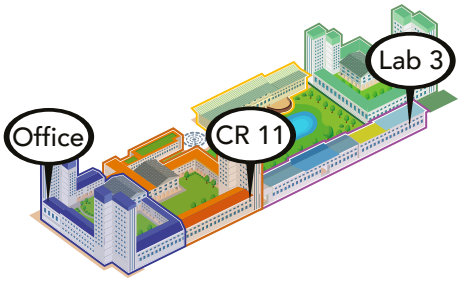
Final Exam:
The final exam will be composed of a combination of theoretical, computational, and experimental problems from the entire semester. Students will be provided with an equation sheet based on the final review session. The problems will be very similar to problem sets and lab activities, so it will be beneficial to review those solutions and be able to reproduce them without notes.

Collaborative Final Project:
If the class unanimously decides, they will collaborate on a creative final project. This project will be an illustrated book to explain optics and imaging concepts for children, i.e. without the use of equations. If this option is chosen, the final review class session will be replaced by time dedicated to work on this final project, and the time reserved for the exam will instead be a presentation of the finished book. Students will complete an assessment of each member's contribution to the project which will impact their marks.

Schedule of Topics

Week 1 Wed, Jan 16 Thu, Jan 17	Properties of Light Intro to Waves (Ch 2)	Thu, Mar 7	Midterm Exam
Week 2 Wed, Jan 23 Thu, Jan 24	Light Propagation (Ch 4)	*Week 8* Wed, Mar 13 Thu, Mar 14	Interference (Ch 9)
Fri, Jan 25	Lab 1: Is this...a Prism?	Fri, Mar 15	Lab 4: Interferometer
Week 3 Wed, Jan 30 Thu, Jan 31	Geometrical Optics (Ch 5)	*Week 9* Wed, Mar 20 Thu, Mar 21	Imaging I: Lenses, Micro-scopes, Telescopes
Week 4 Wed, Feb 6 Thu, Feb 7	*No Class* [Chinese New Year] Polarization (Ch 8)	*Week 10* Wed, Mar 27 Thu, Mar 28	Imaging II: Sensors
Fri, Feb 8	Lab 2: Polarization	Fri, Mar 29	Lab 5: 3D Images
Week 5 Wed, Feb 13 Thu, Feb 14	Lasers, Gaussian Beams, and more Waves (Ch 7)	*Week 11* Wed, Apr 3 Thu, Apr 4	Human Vision I
Week 6 Wed, Feb 20 Thu, Feb 21	Diffraction (Ch 10)	*Week 12* Wed, Apr 10 Thu, Apr 11	Human Vision II
Fri, Feb 22	Lab 3: Diffraction with Ruler & Spectrometer	Fri, Apr 12	Lab 6: Optical Tweezers
Feb 23-Mar 3	*No Class* [Semester 2 break]	*Week 13* Wed, Apr 17 Thu, Apr 18	Advanced Topic Final Review
Week 7 Wed, Mar 6	Midterm Review?	Wed, May 8	Final Exam OR Final Project Presentation

Chapters in parentheses are from Hecht:
it is not necessary to read the entire chapter (see Canvas)
All meetings except the final exam are 10:30-11:50
Normal class meetings will be held in Classroom 11
Lab meetings will be held in Lab 3 (dress appropriately)
Office hours time and location TBD



Late Assignment Policy:
Assignments will be considered late if they miss the deadline without an AD note or Medical Certificate from a Doctor. Late assignments will be penalized 10 % per day late. Students should request an extension at least one day in advance if they anticipate a scheduling conflict.

Attendance Policy:
Students are expected to attend all classes. Students should notify the instructor as far in advance as possible of planned and unplanned absences.

Lab Safety/Etiquette:
This course has a laboratory component requiring students to complete online safety training through NUS at https://ivle.nus.edu.sg. The required modules are:

1. Introduction to Laboratory Safety and Health in NUS (OSHGEN02)
2. Chemical Safety (OSHCHM01)
3. Laser Safety Training (OSHRAD02)

After completing each safety course, save a screen shot of the e-certification or completion mark and email it to the instructor (ben.olsen@yale-nus.edu.sg) as well as the lab exec, Sim Joo Huang (joohuang.sim@yale-nus.edu.sg). These must be completed prior to lab activities.

Academic Integrity Policy:
Yale-NUS College expects its students to abide by the highest standards of academic integrity as a matter of personal honesty and communal responsibility. Acting with academic integrity requires that

- students do their own work,
- students not interfere with the work of others,
- students accurately and honestly represent the content of their work, and
- students properly attribute others' work.

Violations of the College's academic integrity standards undermine both the community and the individual growth of students. Accordingly, they will be addressed with the utmost seriousness and sanctions ranging from grade penalties to expulsion. Examples of violations of academic integrity include plaigarism, copying or sharing homework answers, referencing solutions online or from previous versions of this course, submitting work completed for one course as "new" work for another course, or fabricating or falsifying research data. For more information, please visit the Student Services website, Policies and Procedures section: https://studentlife.yale-nus.edu.sg/policies/academic-integrity/

The Yale-NUS Library provides resources on citations and plaigarism here: http://library.yale-nus.edu.sg/plagiarism/

Learning Accommodations:
Students who require academic accommodations must make arrangements through the Center for Teaching and Learning at https://teaching.yale-nus.edu.sg/student-support/learning-accommodation/. However, even if there are issues that are not officially recognized by the college, adjustments to the course may be possible that will benefit all students. You are encouraged to discuss ways to improve your learning with your instructor.

Nondiscriminatory Language and Conduct:
This course encourages non-discriminatory language and conduct. Students should not use racist, sexist or other discriminatory language in class discussions or written work.

Course Modifications:
During the course, it may make sense to modify the outlined schedule. The instructor reserves the right to modify elements of the course and will notify students accordingly (in class and posted to the course website).

Use of Online Elements:
This course will use Canvas, and potentially Turnitin. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, e-mail accounts, etc. may be apparent to the other students. Work evaluated with Turnitin will be added to a database for comparison. Continuation in this course will be deemed consent to these policies. Please direct questions or concerns to the instructor.