

W Z Ç •] • ò Optics Lab Course

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contemporary subjects in modern optics $X d Z o \dot{s} \mu \epsilon P] v \cdot \acute{A}] \dot{s} Z \epsilon \acute{A}] \acute{A} \} ($
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Interaction with Instructor

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I try to respond to email daily, Monday through Friday. Generally, expect to receive a response to most weekday email within 24 hours. On weekends, I cannot guarantee a response to email.

So, that I can recognize email message from you, I ask that you type “W, z ^ ð ĩ ĩ ~ } Œ ñ ĩ ĩ • ĩ Ç } μ o
v u” in the subject box of every email you send to me. It’s possible that I may not read your email message without this information. Please use a proper greeting and sign your name to all email message you send to me.



Course Objectives

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After completing this course, you will be able to

1. Understand natural phenomena and science/technology with relevant E&M & Optics Theories
2. Get deep knowledge on classical and modern optics
3. Acquire skills to handle optical apparatus and components
4. Experience historically well known optics experiments with modern test equipment
5. Improve your creativity by conceiving new ideas in lab experiments



Additional Requirements

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- Novell Login ID and student Z-ID number
- Labs: recording device (digital video camera, smart phone, etc)
- Public web account (youtube, etc) to upload movie files
- Math Software (MathCAD, Mathlab, Python, etc) and computer interface programs

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- The preferred method of teaching consists of a variety of instructional techniques including lecture and lab exercises. The course will begin each class with lectures on each topic and follow-up quizzes. Students will have chances to utilize their learning to lab exercises to reinforce the concepts and principles presented.

- This course is primarily hands on in its approach to technology and learning. Therefore, it will include numerous lab activities and projects to offer you the opportunity to demonstrate your abilities and new skills

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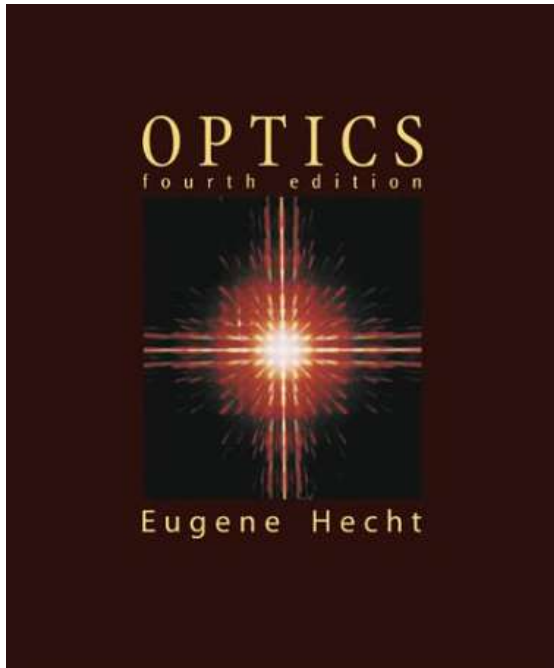
- We will be mainly interacting through the existing optics lab homepage that already have many resources for the course. The website is often updated, so the students will need to keep monitoring it over the semester.

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- Blackboard (Bb) is the online course management system (CMS) that we will be using extensively throughout the semester. Several course documents are available on our course site and others will be available at different times throughout the semester.



Books for Bed Time Reading



Required Textbook:

Eugene Hecht, Optics, 4th/5th ed.

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JE James, A Student's Guide to Fourier Transforms

RN Bracewell, The Fourier Transform and its Applications

GR Fowles, Introduction to Modern Optics



More References of Advanced Optics

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- (1) John D. Joannopoulos, et. al, Photonic crystals: Molding the Flow of Light (2nd Edition)
- (2) Maksim Skorobogatiy, Jianke Yang, Enlarge Image Fundamentals of Photonic Crystal Guiding, Cambridge University Press, 2008, ISBN: 9780511575228

3 O D V P R Q L F V

- (1) Stephan Alexander Mier, Plasmonics: Fundamentals and Applications
- (2) Mark L. Brongersma, Pieter G. Kik, Surface Plasmon Nanophotonics (Springer Series in Optical Sciences)
- (3) Eric C. Le Ru, Pablo G. Etchegoin, Principles of Surface-Enhanced Raman Spectroscopy: And Related Plasmonic Effects

0 H W D P D W H U L D O V

- (1) Metamaterials with Negative Parameters: Theory, Design and Microwave Applications, Ricardo Marqués, et. al.
- (2) Optical metamaterials: Fundamentals and Applications, Wenshan Cai, Vladimir Shalaev
- (3) Metamaterial handbook: Two volume slipcase set, Filippo Capolino
- (4) Metamaterials: Theory, Design, And Applications, Tie Jun Cui, David R. Smith, Ruopeng Liu
- (5) Electromagnetic Metamaterials: Transmission Line Theory And Microwave Applications : The Engineering Approach, Christophe Caloz, Tatsuo Itoh
- (6) Negative-Refractive Metamaterials: Fundamental Principles and Applications, George V. Eleftheriades
- (7) Metamaterials: Physics And Engineering Explorations, Nader Engheta, Richard W. Ziolkowski

8 O W U D I D V W 2 S W L F V

- (1) Andrew Weiner, Ultrafast Optics, ISBN: 978-0-471-41539-8
- (2) Robert W. Boyd, Nonlinear Optics (3rd)
- (3) Frits Zernike, AJohn E. Midwinter, Applied Nonlinear Optics
- (4) Jean-Claude Diels, Wolfgang Rudolph, Ultrashort Laser Pulse Phenomena



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1. Index of Refraction of a Glass Prism and Dispersion

September 5, 2012

To measure the index of refraction of a triangular glass prism by the minimum deflection method. By doing this at several wavelength of light, the dispersion of the index of refraction can be measured



Lab_01.pdf



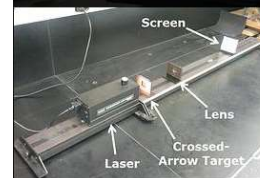
2. Optical Fiber Interrogator

December, 08 2013

To observe grating dynamics in optical fiber. A wide scope of creativity can be embedded in the experiment, depending upon how the devices are set up with test samples.



Lab_02.pdf



3. Thin Spherical Lenses

December, 08 2013

To study thin spherical lenses.

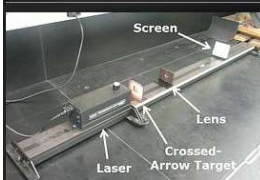
Chapter 5: Geometrical Optics

5.2: Lenses

5.2.3: Thin Lenses (Thin Lens Equation)



Lab_03.pdf



4. Thin Spherical Lenses-II

December, 08 2013

To study a special thin lens combination and learn more about thin lens object and image making.

Chapter 5: Geometrical Optics

5.2 Lenses

5.2.3 Thin Lens Equation



Lab_04.pdf



5. Polarization 1 (Malus' Law)

December, 08 2013

To test Malus' Law with Real Polarizers

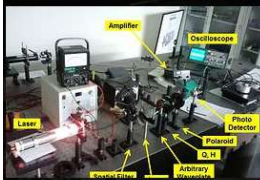
Chapter 8: Polarization

8.2 Polarizers

8.2.1 Malus' Law



Lab_05.pdf



6. Polarization 2 (Retardation Plates)

December, 08 2013

To study the function and principles of half-wave plates and quarter-wave plates. Also to establish and analyze elliptically polarized light

Chapter 8: Polarization

8. 7: Retarders



Lab_05.pdf



7. Michelson Interferometer

December, 08 2013

In the optics laboratory are sets of Pasco Precision Interferometers, on which we may set up several different kinds of interferometers, including the Michelson, Fabry-Perot, and Twyman-Green interferometers.

Chapter 9: Interference

9.4: Amplitude-Splitting Interferometers

9.4.2: Mirrored Interferometers



Lab_07.pdf



8 - 10. Fraunhofer Diffraction

December, 08 2013

To study the Fraunhofer patterns of light from single, double, and multi slits. Accurate measurements could yield the wavelength of monochromatic light, provided that the slit width was given accurately.

Chapter 10: Diffraction

10. 2: Fraunhofer Diffraction



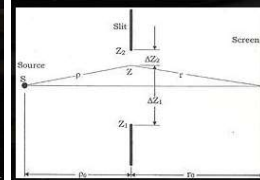
Lab_08.pdf



Lab_09.pdf



Lab_10.pdf



11. Fresnel Diffraction

December, 08 2013

To study the complex phenomenon of Fresnel Diffraction from a single slit and to qualitatively compare observed spectra with spectra computed from Fresnel integrals.

Chapter 10: Diffraction

10. 3: Fresnel Diffraction



Lab_11.pdf

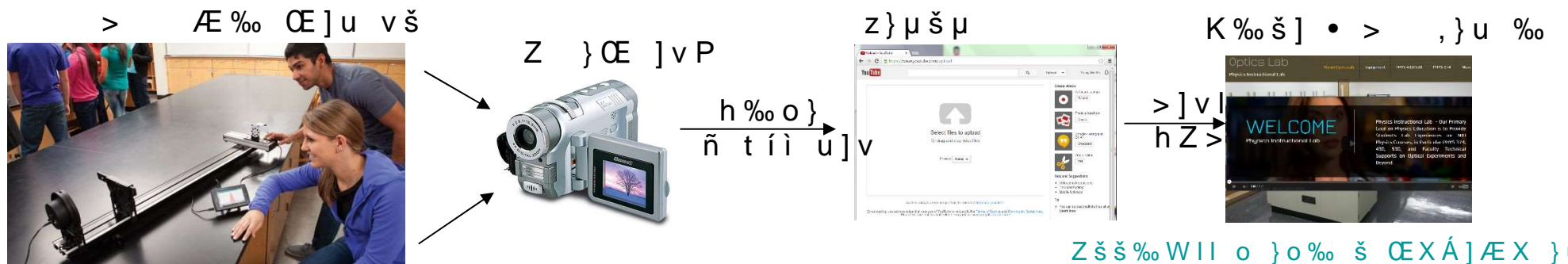


Lab Report

Each experiment will require a lab report. The handout for each experiment will deal mostly with the equipment and procedure, with some theory for guidance. You will be responsible for the theory part, in some cases, along with the presentation of data and some kind of discussion.

As this is where you give thought to the results and explain how well they verify the theory behind the experiment. Alternatively, if there is a discrepancy, you should attempt to explain the reason. The paper should be typed with the following sections included in the same order:

- Title
- Objective
- Theory – often just some master equation and a mention of where it came from.
- Procedure – sketch of procedure from handout, or else, what you actually did if different than handout.
- Data and graphs.
- Discussion – did experiment verify equation? or if not, why not?
- **Visualization of Lab Activity- performing a lab experiment is recorded with any type of recording device (video camera, smart phone, etc) and video files should be submitted with a lab report. The procedure is detailed below**



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For Graduates (530- Fall/2016)

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Project Evaluation

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- Title
- Biography
- Abstract
- Introduction
- Theoretical background
- Method/Procedure
- Data and graphs.
- Analysis
- Discussion
- Video file

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- Oral Presentation
- 10 min (talk) + 5 ~ 10 min (Q&A and discussion).
- Update of progress
- Narrate goal, background, logistics, methodology, progress, results, analysis, discussion, etc
- Powerpoint slides strongly recommended
- Please feel free to contact me and technical managers, should you have any help and questions

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(1) Midterm exam will be held sometime before spring recess. ~ D] š OE u AE 9 A

(2) Final Exam is scheduled d μ • Ç U ò U í r í & W ñ ò DE 9 A

(3) Lab/Semester-Project:

- 10 labs are required. z } μ v š } • } OE ò i S] vo š Z š o š } %o •• š Z } μ OE • X

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- Late submission allowed, but it will be subject to penalty of ñ ò 9 OE μ š] } v (A means no score for a lab report submitted two weeks after the deadlines.

- 4 Progress reports/presentations required for semester project. z } μ v š } • } OE ò i S] vo š Z š %o OE } i š š } %o •• š Z } μ OE • X ~ Z %o } OE š ~ í ñ 9 • = W 9 • • v š š] } v ~ í ñ 9

(4) Homework (í ñ) 9 Late submission allowed, but it will be subject to penalty of í ò 9 OE μ š] } v it Ç means no score for a homework submitted 10 days after the deadlines.

(5) In-Class Q&A (í ò 9

(6) Class Attendance (ñ) 9 z } μ OE o •• š š v v ò i 9 OE š } À š } %o •• š Z } μ OE • X

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•Grading Scale:

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Course Policies

In-Class Exercises and Attendance

In the past, people who have skipped a lot of classes have received very bad grades (or failed). Conversely, people who've come to most or all of the classes nearly always receive A's and B's. **W**o • v}š W]vr o •• Æ Œ]•• vv}š Á}μo]v Ç}μŒ •š]vš Œ •šU šZ Œ (}Œ U š} Œ Pμo Œ oÇ šš v]v•š Œ μ š]]v (}Œ u]•• o ••X

Participation and Classroom Demeanor

I expect each of you will have something to contribute to the class – please ask questions and be prepared to speak when called upon. Even though classroom participation does not count toward the final grade I expect that your participation and demeanor be active, helpful, and respectful of peers, the instructor, and guest speakers, if any.

Late Work

Homework/lab report will be **firmly** due on its due date. Late Homework/lab report will be accepted but with a 50% penalty per week (report) or a 10 % penalty per a day (HW). You can work with others on homework but write it up yourself with your own words. Explain your work.

Tardiness

If you personal an/or professional schedules prevent you from regularly arriving to class on time, please discuss this with the instructor immediately. Being tardy twice (15 minutes or more late) will reduce total earned by 5 points for each late arrival thereafter.



Course Policies

Academic Integrity If you are “caught” in any act of academic dishonesty in this course, no matter your total points earned for the course at the end of the semester, your final grade will be reduced by **at least one letter grade**

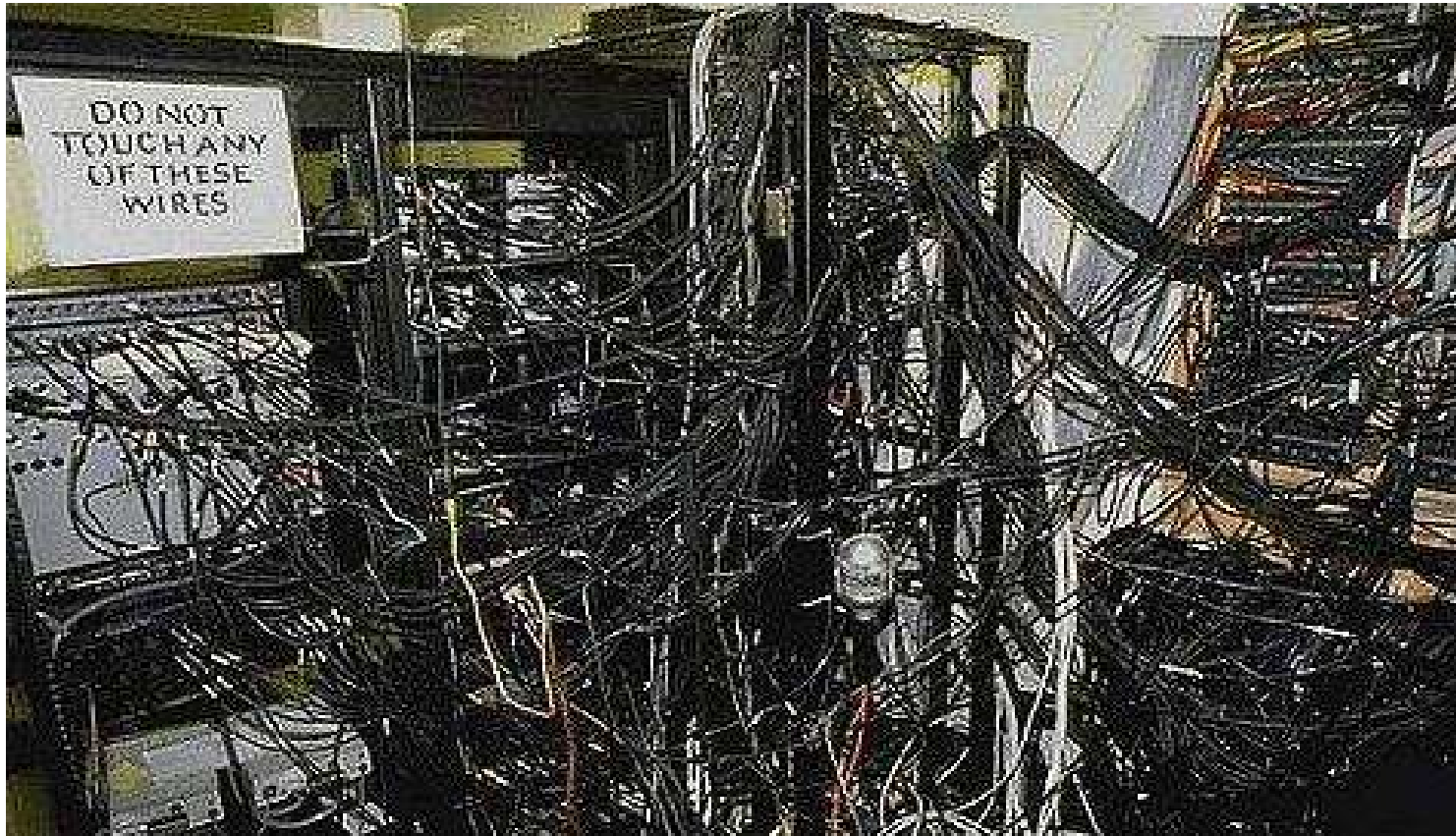
Good academic work must be based on honesty. The attempt of any student to present as his her own work that which he or she has not produced is regarded by the faculty and administration as a serious offense. Students are considered to have cheated if they copy the work of another during an examination or turn in a paper or assignment written, in whole or in part, by someone else. Students are responsible for plagiarism, intentional or not, if they copy material from books, magazines, or other sources without identifying and acknowledging those sources or if they paraphrase ideas from such sources without acknowledging them. Students responsible for, or assisting others in, either cheating or plagiarism on an assignment, quiz, or examination may receive a grade of F for the course involved and may be suspended or dismissed from the University (2010/2011 NIU Undergraduate Graduate Catalog, (<http://catalog.niu.edu/cotent.php?catoid=14&navoid=413>)



Northern Illinois
University

Why study optics?

Lasers and fiber optics will soon replace most wires.



Optics often has some counterintuitive ideas



But when you think about them for a while, they make sense.



What will be covered (1)

Some of wave motion.

Quick review of elementary Maxwell's equations, light.

We will begin with some phenomenological descriptions and progress to the Fresnel equations. Fresnel equations are the basis for most of the interactions of light with matter and are very important. We will spend little time on sections 4.4, 4.5, & 4.6.

We don't want to spend a lot of time on lenses, mirrors, prisms, etc., but we will examine a few things. We will begin with elementary descriptions of refraction at curved surfaces, and then jump ahead to section 6.2 and develop the rest of the theory of thin and thick lenses by using a matrix approach. We will go back and look at some examples to put the theory on a sound basis. We will then make brief mention of properties of selected mirrors and prisms, aperture stops, aberrations and finish with a couple of lectures on Fiber optics and thin film wave guides.



What will be covered (2)

We will dwell on sections 7.1 through 7.4. The rest is interesting but we will reach back later if we need any of those developments in our theories.

We will develop a sophisticated mathematical description of polarization including Jones vectors and matrices. Then we will briefly discuss practical devices for creating the unusual polarization states.

We probably will go back and pick up the Stokes treatment of reflection and refraction (Section 4.5) and then proceed to multiple reflection situations and interferometers.

We will investigate the theories of diffraction for both the simpler Fraunhofer diffraction and the complicated Fresnel diffraction. There are many diffraction experiments in our repertoire.

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Tentative Timeline (430/530 2016-Fall)

No	Date	Tue	Thur	Chapter	PPT	Topic	HW		Lab (430)		Project Report/Presen (530)	
	Month						assn	Due	Handout	Due	Handout	Due
1	8	23		1	1	Syllabus (Orientation)/Introduction (historical Review)					1	
2			25	2	2	Mathematical basis	1		1			
3		30		3	3	EM Theory (Maxwell)						
4			1	3	4	EM Theory (Waves)		1		1		
5	9	6							2		2	
6			8	3	5	EM Theory (Light/Matters)						1
7		13					2			2		
8			15	4	6	Propagation (Scattering)			3			
9		20						2				
10			22	4	7	Propagation (Reflection)				3		
11		27							4			
12		29					3					
13	10	4		5,6	8	Geometrical Optics				4	3	
14			6					3	5			2
15		11					4					
16			13			Midterm				5		
17		18		7	9	Superposition		4	6			
18			20				5					
19		25		8	10	Polarization				6		
20			27					5	7			
21	11	1									4	
22			3				6			7		3
23		8		9	11	Interference			8			
24			10					6				
25		15					7			8		
26			17	10	12	Diffraction			9			
27		22						7				
28			24				8			9		
29		29		11	11	Advanced Optics			10			
30	12		1					8				4
31		6				Final				10		

This curriculum schedule can change depending on the progress of the class



Understanding the ideas of each lecture requires the knowledge of the previous lectures

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