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# **ECE 523- Course Syllabus**

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## **ECE 523- – Photonics and Optical Communications**

**Section -**

**SPRING 2014**

**3 Credit Hours**

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### **Course Description**

This course examines photonic systems within the framework of optical communication systems, with an aim to produce students with a foundation and working knowledge of modern photonics concepts/terminology, major opto-electronic devices/components, and optical communication systems. This course involves two 75-minute lectures each week. Three in-class midterms will be given during the semester and an individually written final paper assignment will take the place of a final exam. Regular attendance is mandatory, and University policy for absences will be followed.

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### **Learning Outcomes**

#### **I. Fundamentals of Light, Optics and Optical Fibers**

In the first segment the student should get an understanding of the properties of light, how to use lenses, mirrors, gratings, filters and other optical elements in simple optical systems. Once these basics are covered, these concepts are used to cover the fundamentals of rectangular and cylindrical waveguides. Optical fibers are then studied with an emphasis on the design considerations that go into choosing the appropriate fiber for various applications. Analytical skills will be developed in using matrix methods to solve optical problems, and electromagnetic wave theory to solve wave guide problems.

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#### **II. Lasers/ LEDs Light Sources**

This will primarily cover the principles of optical amplifiers and lasers. Stimulated emission, Rate Equations, Photon lifetime and a variety of laser types will be discussed. While the basic principles that govern all types of lasers (gas, solid state, fiber, diode) will be studied, we will likely focus on the HeNe laser to show the mathematics.

#### **III. Photodetectors/ Receivers**

As time permits, photodetectors and receivers will be discussed. Since signal modulation and "speed" are critical, driver circuits and bandwidth considerations will be discussed. The advantages and disadvantages of photodiodes, photoconductors, photomultiplier tubes and other optical detectors will be covered, with an emphasis on photodiodes. We also hope to gain an understanding of receiver-design and performance issues including noise, sensitivity, and bandwidth.

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## Course Structure

The intent of this course is to cover the fundamentals of optoelectronic devices and photonic systems with an emphasis on optical communications. Several HW assignments will be assigned, usually with one week to work the assignment. There will be three midterms and a final exam paper. Midterms will occupy an entire class period and may be given as a take-home exam or in-class at the instructor's discretion. Emphasis for each Midterm will be on the more recent material. The final exam paper is very important for the final grade. In the past I have found that it separates out the grades.

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## Instructors

**Michael W Kudenov** (mwkudeno) - *Instructor*

**Email:** [mike.kudenov@ncsu.edu](mailto:mike.kudenov@ncsu.edu)

**Web Page:** <http://research.ece.ncsu.edu/osl/>

**Phone:** (919) 515-3473

**Office Location:** MRC Bldg, Room 437 (Centennial Campus)

**Office Hours:**

Thursday: 1:00-2:00 pm, in MRC 437

Monday: Virtual Office Hours. 2:00pm-3:00pm with Dr. Kudenov; Skype username: mkudenov

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## Course Meetings

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### Lecture

**Days:** TH

**Time:** 11:05am - 12:20pm

**Campus:** Centennial

**Location:** EB2 Room 1228

*This meeting is required.*

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## Course Materials

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### Textbooks

**Fundamentals of Photonics** - *Saleh and Teich*

**Edition:** 1st Ed., but 2nd also works.

**ISBN:** ISBN-0-471-83965-5

**Web Link:** <http://catalog.lib.ncsu.edu/record/NCSU769206> (Library E-Book, 1st Ed.)

**Cost:** \$120 (or free if you use NCSU library's ebook)

*This textbook is required.*

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### Expenses

None.

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### Materials

None.

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## Requisites and Restrictions

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### Prerequisites

Graduate standing or Senior standing ; Engineering Majors or Physics Majors

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### Co-requisites

None.

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### Restrictions

None.

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## General Education Program (GEP) Information

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### GEP Category

This course does not fulfill a General Education Program category.

### GEP Co-requisites

This course does not fulfill a General Education Program co-requisite.

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## Transportation

This course will not require students to provide their own transportation. Non-scheduled class time for field trips or out-of-class activities is NOT required for this class.

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## Safety & Risk Assumptions

None.

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## Grading

### Grade Components

Component	Weight	Details
Homework and Design Problems	20%	
Midterm 1	20%	
Midterm 2	20%	
Midterm 3	20%	
Final Paper	20%	

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## Letter Grades

### This Course uses Standard NCSU Letter Grading:

97 ≤	<b>A+</b>	≤ 100
93 ≤	<b>A</b>	< 97
90 ≤	<b>A-</b>	< 93
87 ≤	<b>B+</b>	< 90
83 ≤	<b>B</b>	< 87
80 ≤	<b>B-</b>	< 83
77 ≤	<b>C+</b>	< 80
73 ≤	<b>C</b>	< 77
70 ≤	<b>C-</b>	< 73
67 ≤	<b>D+</b>	< 70
63 ≤	<b>D</b>	< 67
60 ≤	<b>D-</b>	< 63
0 ≤	<b>F</b>	< 60

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## Requirements for Credit-Only (S/U) Grading

Performance in research, seminar and independent study types of courses (6xx and 8xx) is evaluated as either "S" (Satisfactory) or "U" (Unsatisfactory), and these grades are not used in computing the grade point average. For credit only courses (S/U) the requirements necessary to

obtain the grade of "S" must be clearly outlined.

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## Requirements for Auditors (AU)

Information about and requirements for auditing a course can be found at <http://policies.ncsu.edu/regulation/reg-02-20-04>.

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## Policies on Incomplete Grades

If an extended deadline is not authorized by the Graduate School, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at <http://policies.ncsu.edu/regulation/reg-02-50-03>. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at [http://www.fis.ncsu.edu/grad\\_publicns/handbook/](http://www.fis.ncsu.edu/grad_publicns/handbook/)

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## Late Assignments

Any homework handed in after the due date/time described above will be considered late (unless you make previous arrangements with the Professor, or can demonstrate an emergency situation after the due date/time). Late homework will be penalized –10% and accepted until 10:00am the day after it was originally due. In this circumstance, you may hand in the assignment in several ways: (a) deliver a hardcopy to my office in MRC; or (b) email scanned images. If you email me scanned images, they MUST BE LEGIBLE and paginated. It is often the case that I receive photos taken with a smartphone. These are only acceptable if you take them in proper lighting and they contain minimal motion blur and sufficient spatial resolution to read. In the event the images are not legible, the homework will not be accepted.

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## Attendance Policy

For complete attendance and excused absence policies, please see <http://policies.ncsu.edu/regulation/reg-02-20-03>

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### Attendance Policy

"Full participation in classes, laboratory period and examinations is expected of all students . . . Instructors may use reasonable academic penalties commensurate with the importance of the work missed because of unexcused absences."

- NCSU REG 02.2.03

**If you are absent during lecture, it will significantly impact your performance on the exams. This is emphasized by the fact that you will miss out on the post-lecture tutorials, which are directly related to the exam material. In the past, students who attended class regularly typically scored 1 letter grade higher than those who did not, by virtue of these lecture tutorials and in-class voting or think-pair-share questions.**

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### Absences Policy

Per University regulations, excused absences must fall into one of two categories: sanctioned anticipated situations and documented emergency situations. Anticipated situations (e.g., participation in official University functions, court attendance, religious observances, or military duty) *must be submitted in writing at the beginning of the semester or one week prior to the anticipated absence*. Emergency absences (e.g., student illness, injury or death of immediate family member, *must be documented by the Student Organization Resource Center 515-3323*) within one week following the emergency. Make-up work will be allowed only in situations where absences were excused. Please consult the following site for further information on University attendance regulations: <http://policies.ncsu.edu/regulation/reg-02-20-03>

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## **Makeup Work Policy**

Makeup for university approved absences will be offered on a case-by-case basis, as determined by the instructor. Makeup opportunities without a previously authorized excuse **will not be given**.

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## **Additional Excuses Policy**

None.

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## **Academic Integrity**

### **Academic Integrity**

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at <http://policies.ncsu.edu/policy/pol-11-35-01>

None.

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### **Academic Honesty**

See <http://policies.ncsu.edu/policy/pol-11-35-01> for a detailed explanation of academic honesty.

None.

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### **Honor Pledge**

Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment."

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## **Electronically-Hosted Course Components**

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

**Electronically-hosted Components:** Moodle will be used to distribute all course materials. It will also be used to inform you of due dates for homeworks, tests, and quizzes.

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## **Accommodations for Disabilities**

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, student must register with the Disability Services Office (<http://www.ncsu.edu/dso>), 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at <http://policies.ncsu.edu/regulation/req-02-20-01>.

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## **Non-Discrimination Policy**

NC State University provides equality of opportunity in education and employment for all students and employees. Accordingly, NC State affirms its commitment to maintain a work environment for all employees and an academic environment for all students that is free from all forms of discrimination. Discrimination based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or NC State University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or NC State University policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at <http://policies.ncsu.edu/policy/pol-04-25-05> or [http://www.ncsu.edu/equal\\_op/](http://www.ncsu.edu/equal_op/). Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation

should contact the Office for Equal Opportunity (OEO) at 919-515-3148.

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## Course Schedule

**NOTE:** The course schedule is subject to change.

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### **Lecture TH 11:05am - 12:20pm – Optical Fundamentals, Diffraction, and Wave Theory – 01/07/2013 - 01/25/2013**

Geometrical optics, diffraction, interferometry, and wave theory.

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### **Lecture TH 11:05am - 12:20pm – Polarization, Waveguides, Dispersion – 01/25/2013 - 03/01/2013**

Polarized light, glass waveguides (slab, cylindrical), material dispersion, distortion (modal) and waveguide dispersion.

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### **Lecture TH 11:05am - 12:20pm – Optical Sources, Detectors, and Lasers – 03/04/2013 - 03/29/2013**

Gas lasers, diode lasers, light emitting diodes, PN junctions, stimulated emission and absorption, rate equations.

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### **Lecture TH 11:05am - 12:20pm – Noise in Optical Detection – 04/01/2013 - 04/11/2013**

Detector noise, radiometric transfer, SNR estimations.

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