Revised 9/4/08

6.637 Optical Signals, Devices and Systems

Course Syllabus and Outline - Fall 2008

6.637 covers the fundamentals of optical signals and modern optical devices and systems from a practical point of view. Its goal is to help the student develop a thorough understanding of the underlying physical principles such that device and system design and performance can be predicted, analyzed, and understood.

Most optical systems involve the use of one or more of the following: **sources** (e.g., lasers and light-emitting diodes), **light modulation components** (e.g., electro-optic-crystal and MEMS light modulators), **transmission media** (e.g., free space or fibers), **photodetectors** (e.g., photodiodes, photomultiplier tubes), **information storage devices** (e.g., optical disk), **information processing systems** (e.g., imaging and spatial filtering systems) and **displays** (e.g., liquid-crystal-on-silicon microdisplays). These are among the topics covered by this course.

Prerequisites: The prerequisite is 6.003. Exceptions can be made by the Lecturer.

Lecture: Room 34-304, TR 2:00-3:30pm

6.161 Laboratory (optional): Optics Lab: 38-633, Time TBA. Optics Lab Phone: x3-4619 (Note: we share the lab phone with 6.115, 6.003, and 6.002).

Course Staff

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Course Website: http://web.mit.edu/6.637

1. Course Content

Homework

One homework problem set will be handed out each week. The homework problems are designed to encourage outside reading, and to strengthen your grasp of the fundamentals. How you got to your answer is very important. Show your work! The grader will deduct points for answers which lack justification. Problem sets will not be accepted after the solutions are handed out. Points will be deducted for late problem sets. Late homework should be handed directly to the TA.

Quizzes

There will be two quizzes during the term. The quizzes will be given during the regular class period. These quizzes will cover broad ideas, as presented in lecture and homework. The quizzes will consist of questions intended to test your knowledge of basic optical principles. These quizzes will be open book (Prof. Warde's class notes). You should not stress over these quizzes. If you have done the reading, attended lectures, completed the homework, you should be well prepared for the quizzes. The quizzes will count for approximately 40 % of your grade (20 % each). These quizzes will enable the teaching staff to diagnose both our teaching and your comprehension.

Research Project

One of the homework assignments will be a two-week research project for which the student will prepare a research paper (20 page limit) and make a conference-style 10-minute in-class presentation. Areas that may be considered for research projects include:

Lasers for next-generation fiber-optic systems
WDM and DWDM challenges
Microdisplay technologies
Flat panel display technologies
Real-time holography
Electronic imaging systems
2-D and 3-D optical storage technologies
Photon-counting with avalanche photodiodes
Optoelectronic networks and processors
Optical neural networks
Adaptive optical systems Optically-controlled phased array radar
Optical inference engines
Fluid velocimeters
Coherence tomography
Recent Advances in Microscopy

Students may work alone or in a team of two on the research project. The presentation must include a discussion of the relevance or the potential impact of the technology on society. The presentations will be graded on: (a) the clarity of the presentation [3 pts],

(b) the substance of the material presented [5 pts], and (c) the creativity/innovation in showing or speculating on the impact or application (present or future) of the technology [2 pts]. The accompanying written report is worth 20 pts.

Grading Policy

Homework will account for 40 % of the final grade, the research project 20 % and the quizzes 40 % (20% each).

2. General Policies

Neatness and Clarity
To ensure that you get the maximum number of points on each homework assignment, make sure to be neat! The TA or grader will not grade messy work. Additionally, messy work will delay turnaround on both problem sets and homework. Questions must be answered clearly and succinctly. The TA will be looking for demonstrated understanding. It is preferred that you explain in words when possible; this will ensure that you get the maximum number of points for your effort. However, do not neglect mathematical rigor. When math is needed, it must have the proper units and be clearly written. However, do not compromise important details.

Labeling and Formatting
Whenever a problem asks for a graph, you must create computer-generated graphs. All graphs must be labeled and titled - a copy of the graph must be transferred to your homework problem solution. Use callouts to point out important regions of your graphs. Any written answers exceeding one page must be typed. It is suggested that you format all your answers using LaTeX or a comparable typesetting package.

Label your answers clearly; the grader will not search extensively for an answer. Circle your answers, and underline key portions of your work which directly aid in the creation of the answer. Points may not be given back if an answer is skipped in the grading process because the answer was difficult to find.

Matlab, Mathematica, LabView and Maple
When computer-based problems are presented, please use Matlab, Mathematica, LabView or Maple to do your work. If you feel much more comfortable with other math packages, that is okay, but please put the code in your public directory along with instructions on its execution. You can download homework-specific Matlab scripts and Matlab notebooks from the website for this class. Please include any code and graphs you use in your solutions. Often, unless stated, graphical solutions may be used, especially if they show that you really understand the material. To use Matlab, Mathematica or Maple on Athena, type: `add matlab`, `add math`, and `add maple` at the Athena% prompt. These software packages can also be found on the MOL machines (6.161 Laboratory)

Late-Work Policy
The TA knows that some of you may have obligations which inhibit your ability (on rare occasions) to turn in work on time. If such an emergency arises, notify the TA before the homework is due (if possible). In order to be fair to your classmates, we must still penalize late work (unless the tardiness was due to medical or similarly urgent reasons). Additionally, an incomplete problem set will not be accepted. We expect you to make an effort on ALL parts of ALL problems. This gives us the chance to see where you are having problems, if any. If you need additional time, ask for it. You will always receive more points for a completed late problem set than an on-time incomplete one (assuming you turn it in before solutions are handed out). If tardiness becomes a chronic problem, it will significantly degrade our final evaluation of your performance.

Collaboration
Collaboration is encouraged. Talking with peers about problems helps everyone ("*To teach is to learn twice*." - Joseph Joubert). However, blatant copying and other forms of cheating will not be tolerated. Always acknowledge your collaborators. In no way can this hurt your grade (in fact, it may help). We care that you learn the material - if you learn it best from a friend, that's fine.

Questions regarding problem sets may be addressed to the class discussion webpage. Collaboration (online) must be done through the moderated collaboration web page. That way everyone has access to the same resources; and if you have a problem or question, someone may be able to help you -- including your peers. You can find the collaboration page on the class website:
http://scripts.mit.edu/~6.161/wikiFA06/index.php?title=Main_Page. This site was designed to aid you in obtaining relevant data and information for your studies in 6.637. This site will provide a resource where you may: access homework, communicate with classmates, sample quiz material and sometimes view lecture/tutorial notes. Additionally, you will be able to find applicable scripts and other homework aides here. This site will be where updates to homework assignments, and notes are posted. Since this page is updated often, make sure to refresh your browser every time you view it.

Plagiarism

While collaboration is encouraged, plagiarism will not be tolerated. Please become familiar with the various forms of plagiarism so that you avoid making embarrassing and perhaps costly mistakes. Here are two MIT websites where you can learn more about plagiarism:
http://web.mit.edu/writing/Citation/plagiarism.html
http://web.mit.edu/academicintegrity/handbook/handbook.pdf

Office Hours
Office Hours will be conducted weekly by appointment. Office hours will address questions from the lectures and problem sets. Office hours may also include hands-on demonstrations of applied concepts. While office hours are not mandatory they may

cover concepts and material that may show up on quizzes and homework. Students are expected to ask questions and come to office hours prepared. Questions and concerns addressed on the class electronic mailing list, as well as the class collaboration page may be addressed in office hours.

3. Textbooks and Reading Materials

Some of the topics that we will cover are still areas of active research and are not yet treated in textbooks. Consequently, a combination of class notes and lecture slides will be provided on each topic. However, several of the basic concepts are covered in the following textbooks:

1. J. W. Goodman, *Fourier Optics*, 3rd Edition, Roberts & Co., 2005
2. A. Yariv, Optical Electronics in Modern Communications, 5th Edition, Oxford University Press, 1997.
3. B. Saleh and M. Teich, *Fundamentals of Photonics*, Wiley, 1991.
4. E. Hecht, *Optics*, 4th Edition, Addison Wesley, 2002.
5. M. Born and E. Wolf, *Principles of Optics*, 5th, 6th, or 7th Edition, Pergamon Press, 1980.
6. F.A. Jenkins and H.E. White, *Fundamentals of Optics*, 4th Edition, McGraw Hill, 1976.

We recommend you purchase the book by Hecht. Hecht's *Optics* can be purchased at the Coop or Quantum books (Quantum is much cheaper than the Coop). Purchase of the other textbooks is not essential. These books are on reserve in the Barker Library - but occasionally disappear during the term (especially when problem sets are due). They are intended for use as reference material. Please note that Hecht is a required book for 8.03, and Saleh is recommended for 6.631.

Portions of the material we will cover can also be found scattered throughout a number of journals and conference proceedings that include:

Journal of the Optical Society of America
Applied Optics
Optics Letters
Applied Physics Letters
Optics Communications
Optical Engineering
Proceedings of the SPIE (Society of Photo-Optical Instrumentation Engineers).

Occasionally, students will be expected to read and apply material covered in articles selected from these journals.