MASSACHUSETTS INSTITUTE of TECHNOLOGY
Department of Electrical Engineering and Computer Science

*6.161 Modern Optics Laboratory*
*6.637 Optical Signals, Devices & Systems*

Fall Term 2006 **Final Project General Information** Issued Thrs. 11/16/2006

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**Final Project, Important Dates:**
Projects begin date: Thrs. 11/16/05
Project presentation date (for staff preview only): Mon. 12/11/06
Project presentation Date (in Class): Tues. 12/12/06 **Begin 2:00 pm - End 4:00 pm**
Project writeup due date: Wed. 12/13/06 (turned in to 13-3102)
Lab cleanup day (required of **everyone from 6.161**): Thurs. 12/14/06

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## Guidelines for the Final Project Writeup

The final-project report will require a full write-up in journalistic style. It should be on the order of 15 to 20 pages in length (please, no longer... you should be able to condense any relevant prose into that space).

Various resources are available to help you in writing your final report. One that we recommend is the Mayfield Handbook of Technical & Scientific Writing. The staff will be grading your final report on: (1) its scientific merit; (2) organization and content; (3) scope of the project; (4) clear and accurate writing; and, (5) your level of understanding. The staff expects a well-thought-out, well-written, well-conceived report. The timeliness of its submission and your level of understanding on the subject of the report are extremely important. Some basic pointers on the final project:

1. Use words instead of equations whenever possible. This does not mean that you should write "take the integral of g(x) times e to the minus j two pi f-sub-x times x with respect to x over the interval from negative infinity to positive infinity," but rather, it would be more appropriate to use descriptions of well-known functions such as "take the spatial Fourier transform of g(x)."

2. Diagrams and pictures should be simple and well labeled. There should be no question as to the content or meaning of a diagram or picture. Use pictures and diagrams to simplify your work, thereby enabling the reader to come to an easier understanding of the material.

3. Footnote or endnote your sources! If you don't, it's plagiarism. Many students don't adequately reference their sources. Many students think that the instructor will deduct points since there is little 'original' work. The staff does not expect significant scientific breakthroughs from a 6.161 or a 6.637 final project (however, we won't be disappointed if you do manage to revolutionize the field of optics). Don't worry... some advances in scientific knowledge and understanding come from rephrasing and reorganizing ideas presented by previous authors. Just make sure you use your own words, which are based on your own understanding, credited to the appropriate source.

4. Your report must have at least a title page, an abstract, a table of contents, a list of tables, a table of figures, a bibliography, and the body of the report. The body of the report may be further broken down into various sections that should include and Introduction, Approach, Experimental or Theoretical Results, Analysis, and a Discussions and/or Conclusions. Pages should be numbered. Also, use a font size of 10 or larger for the ease of the reader. **However, 6.161 must follow the instructions of the Writing Program Coordinator when they differ from the general guidelines in this paragraph.**

5. Keep any code or long drawn-out derivations in an Appendix; don't bury the reader in equations or code!

### Requirements for the Final Project Presentation

On the Project Presentation Day (in-class), each group will be required to give a 9 minute (maximum) presentation on their final project.

1. Use viewgraphs (overhead transparencies) or PowerPoint slides appropriately (5-8 should be adequate).

2. Use plenty of pictures (do not burden your audience with too much text on your slides).

3. Remember who your audience is!

4. Explain the theory behind your project, explain your experimental method, and explain any data or results you have gathered.

5. Explain any discrepancies between your data and theory.

6. No more than 9 minutes per group for the presentation. This will be *strictly* enforced. You may be under 9 minutes (encouraged).

7. You must arrange a time to practice the presentation beforehand in front of the TA. You should also practice your presentation on your own several times to make sure that you do not go over the specified time – and to ensure that you stay coherent and on-topic.

8. Send a copy of your Powerpoint slides to warde@mtl.mit.edu **at least** one day in advance. We will have a computer in the classroom, but you may bring your own computer if you wish.

9. Presentations will be held in the classroom.

### 6.637 Projects

Below is a list of possible final projects. While we have listed some suggested final projects, you are still encouraged to find and develop your own project – just make sure you talk it over with the staff for approval before you get too far into it.

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.

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

## 6.161 Projects

The 6.161 final project is an opportunity for you to design, analyze and build an optical system of your choosing. This final Lab gives you an opportunity to explore in greater depth an area of interest in optics that you were not able to explore during the earlier portion of the term.

Below is a list of possible final projects. In addition, we have included a list of professors willing to supervise work (within their own labs) that will be related to their group's research interests. During your final project, you will be provided the necessary lab equipment and all the technical help possible to ensure that your experience is both educational and rewarding. While we have listed some suggested final projects, you are still encouraged to find and develop your own project – just make sure you talk it over with the MOL staff for approval before writing up your proposal.

Projects may be conducted individually or in groups of two. Three-person groups are discouraged unless the project you choose warrants more than two people, and this is unlikely.

The final-project report will require a full write-up in journalistic style. It should be on the order of 15 to 20 pages in length (please, no longer... you should be able to condense any relevant prose into that space).

On the Project Presentation Day (in-class), each group will be required to give a 9-minute (maximum) presentation on their final project. This presentation along with a brief in-lab demonstration of your project may be videotaped for posterity. Send a copy of your Powerpoint slides to

warde@mtl.mit.edu **at least** one day in advance. We will have a computer in the classroom, but you may bring your own computer if you wish.

### 6.161 General Final Project Rules

No equipment may be removed from the lab without the permission of the TA! Once removal has been approved, you must sign an equipment checkout form before removing the equipment from the lab. You are financially responsible for any equipment removed from the lab. Any keys issued to you must be returned before the last day of classes. Non-return of lab equipment or keys may result in a failing grade for the class.

You and your lab partner need to choose a final project by the Project Proposal Date. Be sure to have at least three photocopied journal articles or book chapters on the subject that you can show to the staff. You should form groups of 2 people. Write a 1-page proposal about your project, including a division of labor and a timeline (starting from the Project Begin Date). Expect to spend upwards of 40 hours in-lab on the final project, and many more hours outside of lab. You will also be required to attend a lab cleanup session after the last day of classes.

### Outside-Lab Project Supervisors

*Prof. Hank Smith* – optical nanostructures
email: hismith@NANO.MIT.EDU, phone: (617) 253-6865

*Prof. Vladimir Bulovic* – organic LEDs
email: bulovic@MIT.EDU, phone: (617) 253-7012

*Prof. Rajeev Ram* – diode lasers
email: rajeev@MIT.EDU, phone: (617) 253-4182

*Prof. Erich Ippen* – femtosecond optics
email: ippen@MIT.EDU, phone: (617) 253-8504

*Prof. Mark Schattenburg* – nanostructures for space applications
email: marks@SPACE.MIT.EDU, phone: (617) 253-3180

## 6.161 Possible MOL Final Projects

| # of projects available | Project Description |
|---|---|
| 2 | **Lasers:**<br>Rebuild and characterize the $CO_2$ laser<br>Mode-locked Nd:YAG laser repair and characterize<br>Characterize all MOL laser diode samples |
| 2 | **Light Modulation:**<br>Characterize a liquid crystal light modulation cell<br>White light, laser, and imaging characteristics of a membrane-mirror light modulator<br>Acousto-optic and electro-optic device characterization, SAW device characterization<br>Photorefractive effects in $Bi_{12}SiO_{20}$ and $BaTiO_3$<br>Perform an analysis of the birefringent properties of sapphire |
| 3 | **Fiber Optic Sensors and Systems:**<br>Enhanced temperature sensor<br>Enhanced rotation sensor<br>WDM communication (video and audio)<br>Strain measurement sensor<br>Acoustic pressure sensor<br>Laser velocimeter<br>Refractive index / liquid-level sensor |
| 2 | **Interferometry:**<br>Speckle interferometry<br>Free-space sagnac interferometer (rotation sensor)<br>Thin-film optics (soap films, oil films, membranes)<br>Laser microphone |
| 2 | **Metrology (3D and 2D imaging):**<br>Structured light metrology<br>Speckle metrology<br>Fluid flows / thin film velocimetry |
| 3 | **Holography:**<br>Reflection holograms<br>Vander-Lugt experiment<br>Holographic encryption<br>Double-exposure holography<br>Full-color hologram<br>Holographic interconnects |
| 1 | **Fourier-Optics:**<br>Develop and demonstrate novel compact CTLP filters and objects suitable for an in-class demo |