Fall 2018

# Computational Optics (ENGR 030) Syllabus

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# Engineering 030. Computational Optics
*Fall 2018*

## Instructor Information

Prof. Vidya Ganapati
Office: Hicks 218
Office Hours: Thursdays 11:10 am - 12:30 pm, starting Sept. 13
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## Course Objectives

- Understand how optical imaging systems work, and approximations to the underlying physics
- Understand linear and non-linear systems approaches to imaging
- Determine how to engineer optical imaging systems given various applications
- Learn how to critically read and understand research papers
- Expand knowledge of Python including packages Numpy, Scipy, and Tensorflow
- Pose research questions and conduct scientific research

## Course Logistics

*Lecture Times/Location:*
9:55 am – 11:10 am Tuesdays and Thursdays
Hicks 211
Lectures will be interactive, and we will complete some programming and pen-and-paper exercises in class.

*Moodle:*
All course handouts, readings and labs will be posted on the course Moodle page. Labs and reading responses will be turned into Moodle.

*Labs:*
Labs will be self-scheduled. You may complete them at any time in the computer lab, Hicks 212, or on your personal computer. You should complete the labs in groups of 2 or 3. Only 1 lab partner needs to turn in the lab for the group.

Please turn in labs by uploading to Moodle. You should upload a single legible PDF; JPEGs will not be accepted. Places to access a scanner for your homework include the Engineering

Department office (Hicks 203) or the Cornell Library. Please do not upload phone photos. Please see the course schedule for lab due dates.

*Reading Responses:*

Readings and reading response questions for the following week will be posted on Moodle by Thursday of the preceding week when applicable. You must complete the reading response questions prior to each class and upload your responses to Moodle as a single legible PDF.

You are encouraged to discuss the readings with your classmates; however, the reading responses you write up must be your own work and reflect your own understanding.

*Grading:*

Reading Responses: 25% (2 passes allowed)
Labs: 40%
Final Project + Presentation: 25%
Participation: 10%

## Accommodations Statement

If you believe you need accommodations for a disability or a chronic medical condition, please contact Student Disability Services (Parrish 113W, 123W) via e-mail at studentdisabilityservices@swarthmore.edu to arrange an appointment to discuss your needs. As appropriate, the office will issue students with documented disabilities or medical conditions a formal Accommodations Letter. Since accommodations require early planning and are not retroactive, please contact Student Disability Services as soon as possible. For details about the accommodations process, visit the Student Disability Services website. You are also welcome to contact me privately to discuss your academic needs. However, all disability-related accommodations must be arranged, in advance, through Student Disability Services.

## Course Schedule (subject to change)

| ***Week*** | ***Day*** | ***Coverage*** | ***Assignments*** |
|---|---|---|---|
| Week 1 | Tuesday 9/4 | Introduction to Computational Optics, signal processing review | |

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| | Thursday 9/6 | Geometrical Optics | |
| Week 2 | Tuesday 9/11 | Scalar Wave Optics I | Lab 1 posted 9/13<br><br>Reading response questions 1 posted 9/13 |
| | Thursday 9/13 | Scalar Wave Optics II | |
| Week 3 | Tuesday 9/18 | Coherent, Partially Coherent, and Incoherent Imaging | Reading Response 1 due 9/20<br><br>Reading response questions 2 & 3 posted 9/20 |
| | Thursday 9/20 | Fluorescence Microscopy and Point Spread Function Engineering | |
| Week 4 | Tuesday 9/25 | Deconvolution and Noise | Lab 1 due 9/27<br>Lab 2 posted 9/27<br><br>Reading Response 2 due 9/25<br><br>Reading Response 3 due 9/27<br><br>Reading response questions 4 & 5 posted 9/27 |
| | Thursday 9/27 | STORM, PALM, STED, MERFISH | |
| Week 5 | Tuesday 10/2 | Light Sheet and Confocal Microscopy | Reading Response 4 due 10/2<br><br>Reading Response 5 due 10/4<br><br>Reading response questions 6 & 7 posted 10/4 |
| | Thursday 10/4 | Quantitative Phase Microscopy and Fourier Ptychographic Microscopy | |
| Week 6 | Tuesday 10/9 | Information Theory, Source and Channel Coding I | Lab 2 due 10/11<br>Lab 3 posted 10/11<br><br>Reading Response 6 due 10/9<br><br>Reading Response 7 due 10/11 |
| | Thursday 10/11 | Information Theory, Source and Channel Coding II | |

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| | | | Reading response questions 8 posted 10/11 |
| FALL BREAK | Tuesday 10/16 | | |
| | Thursday 10/18 | | |
| Week 7 | Tuesday 10/23 | Inverse Problems and Optimization | Reading Response 8 due 10/25 |
| | Thursday 10/25 | Machine Learning in Microscopy | |
| Week 8 | Tuesday 10/30 | TensorFlow Tutorial I | Lab 3 due 11/1<br>Lab 4 posted 11/1 |
| | Thursday 11/1 | TensorFlow Tutorial II | Reading response questions 9 & 10 posted 11/1 |
| Week 9 | Tuesday 11/6 | Simulation of Maxwell's Equations with MEEP | Reading Response 9 due 11/6 |
| | Thursday 11/8 | 3D Object Recovery | Reading Response 10 due 11/8<br><br>Reading response questions 11 & 12 posted 11/8 |
| Week 10 | Tuesday 11/13 | Imaging in Scattering Media | Lab 4 due 11/15<br>Final Project posted 11/15 |
| | Thursday 11/15 | Segmentation and Classification in Biological Studies | Reading Response 11 due 11/13<br><br>Reading Response 12 due 11/15<br><br>Reading response questions 13 posted 11/15 |

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| Week 11 | Tuesday 11/20 | Introduction to Foldscope | Reading Response 13 due 11/20 |
| | Thursday 11/22 | THANKSGIVING | |
| Week 12 | Tuesday 11/27 | Buffer/Work on final projects | |
| | Thursday 11/29 | Buffer/Work on final projects | |
| Week 13 | Tuesday 12/4 | Buffer/Work on final projects | |
| | Thursday 12/6 | Buffer/Work on final projects | |
| Week 14 | Tuesday 12/11 | Final Project Presentations/Demos | Final Project writeup due 12/11 |