

**Engineering Light**  
KHC EK101  
Fall 2012  
Mondays/Wednesdays  
10:00-11:30 AM  
Room: PHO 901

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Office hours TBA  
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### **Course Description and Objectives**

Students will gain an appreciation for light and its use in three optical instruments: the eye, the microscope, and the telescope. They will study landmark discoveries concerning light, the development of various light sources, the scientific advances that led to our current understanding about the properties and characteristics of light waves and photons. The course includes weekly lectures and in-class laboratory exercises, several field trips, and a semester long project. Students will engage in more than twenty hands-on experiments throughout the semester, to untwinkle the stars with adaptive telescopes, to measure the speed of light using parts hacked from a laser pointer, to make a light bulb like Thomas Edison's, to discover how engineers ruined – and then fixed – the world's first astronomical space telescope, and to use a high-resolution ophthalmoscope to see image photoreceptors and capillary blood flow in their own retinas.

#### **Attendance**

Students are expected to come to every class and to participate in all hands-on experiments. Students are expected to participate in class discussions, to contribute to laboratory and project work, and to complete all assignments on time.

#### **Academic Dishonesty**

Students are expected to abide by both KHC and BU's Undergraduate Academic Conduct Code. The Academic Code of Conduct can be found at <http://www.bu.edu/academics/resources/academic-conduct-code/>.

#### **Grading**

- Participation: 25%
- Team-based project: 25%
- Homework/Quiz/Labs: 50%

### **Course Outline & Readings**

9/5/12 Lecture 1: course introduction

- What engineers do, engineering achievements/challenges
- Course goals
- Why study light

9/10/12 Lecture 2: Edison's light bulb, light and color

- Light and color
- Blackbody radiation
- Electromagnetic spectrum
- In-Class Experiment:
  - Making light bulbs
  - Observing blackbody radiation color

9/12/12 Field Trip: Museum of Science

- Light exhibits on optics, light, color, imaging

9/17/12 Lecture 3: Radiation, Wien's Law, A brief history of optics

9/19/12 Lab Experiments: Circuits and optoelectronics

- Electrical circuits, voltage divider, current source
- Optical modulation
- Photodetection

9/24/12 Lecture 5: Diffraction

- Project Presentations: Residential lighting
- In Class Experiment:
  - Young's double slit, diffraction
  - iPhone spectrometer

9/26/12 Lecture 6: Lenses and Imaging

- In Class Experiment: Telescopes and microscopes

10/1/12 Lecture 7: Magnification and solar collection

- In Class Experiment:
  - Solar irradiance
  - Solar concentration

10/3/12 Lecture 7: Vision, introduction to adaptive optics (AO)

- In Class Experiment:
  - Observing the diffraction limit
  - Blind spot

10/9/12 Lecture 8: Microoptoelectromechanical Systems (MOEMS)

10/10/12 Lab Experiment: Clean room lithography and thin film fabrication

10/15/12 Lecture 9: Electrostatic actuation

- Lab Experiment: Deformable mirror actuation and interferometry

10/17/12 Lecture 10 (Field Trip): "New Trends in Aerospace: MEMS DMs"

- Location: MIT Department of Aeronautics & Astronautics
- NOTE TIME: 4-5pm

10/22/12 Field Trip: Joslin Diabetes Center (retinal scans with AO)

10/24/12 Field Trip: Coit Observatory Field Trip (at sunset, weather permitting)

10/29/12 Lecture 11: Scanning Microscopy

- Lab Experiment: Scanning electron microscopy
- Term Project Discussion

10/31/12 In Class Experiments: More adaptive optics

- Optics of the DVD
- Astigmatic control
- Automatic feedback control
- Aberration compensation
- Beam steering

11/5/12 One-on-one review: Student term project proposals

11/7/12 Lecture 12: Neurophotonics

11/12/12 In Class Experiment: Measuring the speed of light

11/14/12 TBA

11/19/12 No Class

11/26/12 Project interim progress review: In-class presentation, report

11/28/12 No Class

11/29/12 Special Event: Future of Light Symposium

12/3/12 Term Project Presentations

12/5/12 Term Project Presentations

12/10/12 Semester review

### Calendar

| September |     |     |     |     |     |     | October |     |     |     |     |     |     | November |     |     |     |     |     |     | December |     |     |     |     |     |     |
|-----------|-----|-----|-----|-----|-----|-----|---------|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|-----|
| Sun       | Mon | Tue | Wed | Thu | Fri | Sat | Sun     | Mon | Tue | Wed | Thu | Fri | Sat | Sun      | Mon | Tue | Wed | Thu | Fri | Sat | Sun      | Mon | Tue | Wed | Thu | Fri | Sat |
| 26        | 27  | 28  | 29  | 30  | 31  | 1   | 30      | 1   | 2   | 3   | 4   | 5   | 6   | 28       | 29  | 30  | 31  | 1   | 2   | 3   | 25       | 26  | 27  | 28  | 29  | 30  | 1   |
| 2         | 3   | 4   | 5   | 6   | 7   | 8   | 7       | 8   | 9   | 10  | 11  | 12  | 13  | 4        | 5   | 6   | 7   | 8   | 9   | 10  | 2        | 3   | 4   | 5   | 6   | 7   | 8   |
| 9         | 10  | 11  | 12  | 13  | 14  | 15  | 14      | 15  | 16  | 17  | 18  | 19  | 20  | 11       | 12  | 13  | 14  | 15  | 16  | 17  | 9        | 10  | 11  | 12  | 13  | 14  | 15  |
| 16        | 17  | 18  | 19  | 20  | 21  | 22  | 21      | 22  | 23  | 24  | 25  | 26  | 27  | 18       | 19  | 20  | 21  | 22  | 23  | 24  | 16       | 17  | 18  | 19  | 20  | 21  | 22  |
| 23        | 24  | 25  | 26  | 27  | 28  | 29  | 28      | 29  | 30  | 31  | 1   | 2   | 3   | 25       | 26  | 27  | 28  | 29  | 30  | 1   | 23       | 24  | 25  | 26  | 27  | 28  | 29  |
| 30        | 1   | 2   | 3   | 4   | 5   | 6   | 4       | 5   | 6   | 7   | 8   | 9   | 10  | 2        | 3   | 4   | 5   | 6   | 7   | 8   | 30       | 31  | 1   | 2   | 3   | 4   | 5   |

Notes: Class on 11/28 will not be held. Instead students will attend part of the "Future of Light: Neurophotonics" Symposium at the Photonics Center. There is no final exam. Filed trips are planned for 9/12, 10/17, 10/24, and 11/29 as noted in the syllabus.