OPTI x85: Illumination Engineering

Spring 2016: three credit hours. Project-based course.

Instructor
John Koshel, office 403A, jkoshel@optics.arizona.edu, phone 621-6357

Course Goal
To learn basic skills in illumination design, especially the use of design software to carry out an individual project and present the results

Class Schedule
Lecture: F 9.00 am – 10.50 am; OSC 305
Software Lab: M 1.00 – 1.50 pm; OSC 305
You are expected to be in class, using only the videos to supplement the lectures

Office Hours:
Dates and times may be updated!
Friday: 10.50 am – Noon (guaranteed)
All Days: 2.00 pm – 4.00 pm (not guaranteed, but you are the priority if there)
Stop by/Appointment: just let me know when (email is the best way to find me).

OPTI 485/585. Illumination Engineering (3). Fields: Illumination, Nonimaging, and Concentrators; Sources: Incandescent, Fluorescent, LED, HID, Modeling, and Experimental Measurement; Modeling: Ray Tracing, Radiometry and Photometry, Color, Polarization, and Scattering; Theory: Radiometry, Photometry, Étendue, Skew Invariant, and Concentration; Design Methods: Edge Ray, Flow Line, Tailored Edge Ray, Non-Edge Ray, and Imaging; Optics: Reflectors, Lightpipes, Couplers, Films, and Hybrids; Applications: Displays, Automotive, Solar, Sources, and Lighting; Special Topics: Software Modeling, Optimization, Tolerancing, and Rendering. Previous requirements: Undergraduate: permission from instructor (OPTI 201R, OPTI 340 or equivalent would suffice); Graduate: OPTI 502 or permission from instructor.

Course Objective:
• Complete a course project: software modeling, theory, public policy, etc.,
• Understand illumination-based modeling software,
• Understand the underlying design principles of nonimaging optics: étendue and edge ray, radiance/luminance, intensity, and illuminance/irradiance,
• Understand the components of an illumination system: source, optics, and target
• Know the limits of ray sampling in nonimaging systems,
• Gain knowledge of a number of applications: lighting, automotive, and displays,
• Gain knowledge of developing areas: optimization, tolerancing, and rendering,
• Learn how to present technical papers in both written (i.e., the professor) and oral (i.e., your peers and the professor) formats, and
• Potentially present and/or publish your work in an optics conference or journal.
GRADING

Without written approval, there will be a score reduction of 10% per day late for any submission. The due date is till midnight of the given day. All submissions will be reviewed for originality.

Undergraduate (OPTI 485) – all dates tentative/may update “scope”:
- Project Proposal:
  - 10%, due Friday, 5 February 2016
  - Paper (2+ pages, with references and pictures)
- Preliminary Design Review:
  - 20%, written due Friday, 11 March 2016; short video, ~ Friday, 1 April 2016
  - Paper (3+ pages text with references, graphics are additional)
- Critical Design Review (CDR):
  - 40%, due final couple weeks
  - Poster/Oral presentation (15%)
    - Depends on the number of students in the class
    - Poster: Friday, 29 April 2016 (during class session)
    - Oral: during class sessions and potential extra session
  - Paper (25%; 7+ page report, with references and pictures), due Friday, 6 May 2016
- Class/Project Day Participation
  - 10%, attending lectures; and questions during presentations
- Homework/“Quiz”:
  - 20%; to be determined, weekly “quiz”

Graduate (OPTI 585) – all dates tentative/may update “scope”:
- Project Proposal:
  - 10%, due Friday, 5 February 2016
  - Paper (3+ pages, with references and pictures)
- Preliminary Design Review:
  - 20%, written due Friday, 11 March 2016; short oral talk, ~ Friday, 1 April 2016
  - Paper (5+ pages text with references, graphics are additional)
- Critical Design Review (CDR):
  - 40%, due final couple weeks
  - Poster/Oral presentation (15%)
    - Depends on the number of students in the class
    - Poster: Friday, 29 April 2016 (during class session)
    - Oral: during class sessions and potential extra session
  - Paper (25%; 10+ page report, with references and pictures), due Friday, 6 May 2016
- Class/Project Day Participation
  - 10%, attending lectures; and questions during presentations
- Homework/“Quiz”:
  - 20%; to be determined, weekly “quiz”

D2L is used throughout the class for providing the lectures, assignments, and so forth. You can hand in assignments in hardcopy form, but it is preferred if you use D2L.
TEXTS

**Required Textbook:**
- 2015 Notes provided by instructor via D2L.

**Suggested Textbooks:**

**SCHEDULE**

**Course Outline:** 2-hour lectures once per week, 1-hour laboratory to discuss software and projects

- **Week 1:** Introduction: course discussion, course survey, course project; types of optics, software modeling, radiometry, photometry, étendue, skew invariant, introduction to design methods and sources
- **Week 2:** Sampling: ray trace sampling, Rose Model, appearance modeling.
- **Week 3:** Sources: LEDs, incandescent, high-intensity discharge, daylight, Fluorescent, source measurement, source modeling, luminaires, lighting.
- **Week 4:** Étendue I: definition, conservation of étendue, examples.
- **Week 5:** Étendue II: concentration, skewness, examples
- **Week 6:** Nonimaging optics I: edge ray principle, compound parabolic concentrator, edge-ray concentrator, truncated CPC, tailored edge ray design, non-edge-ray design,
- **Week 7:** Nonimaging Optics II: flow line method, dielectric design, simultaneous multiple surfaces, hybrid optics.
- **Week 8:** Lightpipes: straight sections, bent sections, principal sections, parameterization, lightguides.
- **Week 9:** Displays I: backlit displays, wedged lightguide, microstructure, back reflector, diffusers, polarizers, source coupler, color modeling.
- **Week 10:** Displays II: polarization, microstructure design, brightness enhancement film, diffuser design, system modeling.
- **Week 11:** Short Oral Presentations/Displays III: projector displays, mixing rods, fly’s eye integrators, system modeling.
- **Week 12:** Optimization: methods, merit function, parameterization, non-uniform rational b-splines, fractional optimization, constraints, reflectors, hybrid optics, lightpipes.
- **Week 13:** Tolerancing: process error, system error, gross error, roughness error, BSDF/BRDF/BTDF, experimental measurement, source binning.
- **Week 14:** Applications/Introduction to stray light: solar energy, concentrators, photovoltaics, automotive, lightpipes, lightboxes, OLEDs; scatter, Fresnel reflections, total integrated scatter
- **Week 15:** Presentations
**COURSE GRADE**

**Components:** as per previous section

- Project proposal: 10%
- PDR: 20%
- CDR presentation: 15%
- CDR report: 25%
- Participation: 10%
- Homework/Quiz: 20%

Without written approval, there will be a score reduction of 10% per day late for any submission. The due date is till midnight of the given day.

**Final Grade:**

- A  90% - 100%
- B  80% - 90%
- C  70% - 80%
- D  60% - 70%
- E  < 60%
ACADEMIC INTEGRITY

According to the Arizona Code of Academic Integrity, “Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student’s submitted work must be the student’s own.” Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. Co-authored work of any kind is unacceptable. Misappropriation of exams before or after they are given will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:

- Reduction of grade
- Failing grade
- Referral to the Dean of Students for consideration of additional penalty, i.e., notation on a student’s transcript re: academic integrity violation, etc.

(http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity)

STUDENTS WITH LEARNING DISABILITIES

Students who need special accommodation or services should contact the Disability Resources Center, 1224 East Lowell Street, Tucson, AZ 85721, (520) 621-3268, FAX (520) 621-9423, email: uadrc@email.arizona.edu, http://drc.arizona.edu/. You must register and request that the Center or DRC send me official notification of your accommodations needs as soon as possible. Please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate. The appropriate office must document the need for accommodations.

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.