

Carnegie Mellon
School of Architecture

48410 / 48726
Lighting

Fall 2008
Monday & Wednesday
12:30 – 13:20 pm
DH A310 (Lectures)
Hunt Lower Level (Labs)

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Recitations:
Monday 6:30-8:00 pm
Tuesday 6:30-8:00 pm

Office Hours:
Wednesday 6:00-7:00 pm

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Overview:

This course introduces fundamental building lighting principles in the context of performance-based building design and diagnostics.

The course will cover relevant aspects of building physics that affect the physiological and psychological experience of buildings, performance metrics, design and benchmarking methodologies, and contemporary simulation tools.

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Topics in lighting include:

Review of physiological and psychological response to the visual environment, analytical and numeric methods for the prediction of lighting conditions in interior spaces, lighting engineering and design methods, and application of computer-aided lighting simulation tools in architectural design.

Note: The syllabus and the schedule may be subject to change as the class progresses.

Structure:

- 7 Lectures covering lighting principles
- 5 Recitations
- 2 Tests (**Sep 17 and Oct 13**)
- 4 Ecotect Sessions
- 1 (Group) Project (**Interim due Oct 13, Final report due Nov 7**)

The 7 lectures will cover fundamental building lighting principles. The lectures are meant to introduce relevant topics; students are expected to cover assigned readings. The tests will be based on both assigned readings and material covered in lectures. Each test will constitute 30% of the overall grade.

5 recitation sessions will be held to go through worked examples (worksheets). Recitations will be held **Monday 18:30-20:00** (according to schedule below) in the crit space at the end of Year 4/5 studio (CFA 214); an **alternate session will be held Tuesday 18:30-20:00**.

- The tests will be in the form of short open questions. (No MCQ)
- There will be NO makeup tests. (0% will be given)
- Many questions in the tests require calculations and the use of scientific calculators (with logarithmic and trigonometric functions). Please bring your own calculators.
- Points will be deducted for wrong answers resulting from erroneous numeric calculations.
- Tests will be based on both assigned readings and material covered in lectures.
- Material covered in lectures is not necessarily covered in the textbooks and vice versa.

The project will be based on modeling, analyzing, and proposing improvements to the lighting performance of a space using Ecotect and Radiance. The project will constitute 40% of the overall course grade. More details on the project are described in the section below.

- Project group size is limited to not more than 3 students.
- Software required will be available on the computer cluster in Hunt Lower Level.
- Submissions (for both interim and final report) include both a written report (in PDF format) as well as digital files (collated in ZIP package).
- All submissions must be through the blackboard. Timeliness of submission will be determined by blackboard timestamp.

Grading:

- Final grade: 30% Lighting Test 1, 30% Lighting Test 2, 40% Project.
- Only appeals to re-grade the **entire** test will be entertained.
- The project will be graded according to the project evaluation criteria listed in section below.
- Grades will be assigned on the following scale:
 - A (91-100), B (81-90), C (71-80), D (61-70), R (0-60)
- Penalty will be imposed for late submissions
 - <12 hours –penalty of 10%
 - 12 – 24 hours – penalty of 20%
 - 24 – 36 hours – penalty of 30%
 - 36 – 48 hours – penalty of 40%
 - 48 – 60 hours – penalty of 50%
 - >60 hours – submissions not accepted

Project (40% of overall grade):

Students are expected to learn, and demonstrate through the project, structured approaches to the quantification, analysis and design, of lighting environments, as well as the effective communication and discussion of their designs. The project is also meant to familiarize students with design variables and software tools (Ecotect and Radiance) in contemporary architecture lighting practice.

- The objective of the project is to apply what was learnt in class to improve the visual performance of spaces.
- Project group size is limited to not more than 3 students.
- You will have to document and evaluate a space on campus, followed by a design proposal with the aid of Ecotect and Radiance, and relevant tools.
- Please consult instructor or TA on the selection of the space for your study. Possible locations are: MM310, CFA Arch Studios, Hallways in Baker Hall/MMCH etc.
- Email list of team members and space selected to instructor by **27th Aug.**

For the project, you have to:

- Conduct field survey of the existing conditions using appropriate instrumentation and document with drawings, pictures and reports.
- Quantify and systematically analyze the lighting quality of the space.
- Propose a lighting design solution to improve the performance of the space.
- Use Ecotect/Radiance for design studies and presentations.
- Communicate your observations and ideas effectively with the aid of methodologies and software tools introduced in class.
- Submit written reports as well as digital CAD files via blackboard.

Interim Report, 13th Oct (40% of project grade) – Evaluation of existing conditions

- Report should include (but not limited to) the following issues:
 - What is the architectural/functional intent of the space?
 - What are the relevant lighting performance metrics and corresponding quantitative metrics?
 - What is the appropriate method to analyze the lighting performance?
 - What are other aspects/constraints relevant to the space?
- Submit letter-sized written report (including figures and tables) in PDF format, no more than 5 pages.
- Submit all working files, including Ecotect (eco) and Radiance (rif, rad, pic) files.

Final Report, 7th Nov (60% of project grade)– Proposed Design

- Report should include (but not limited to)
 - Base analysis (items covered in interim report)
 - Design intent and method
 - Analysis of results
- Submit letter-sized written report (including figures and tables) in PDF format, no more than 10 pages.
- Submit all working files, including Ecotect (eco) and Radiance (rif, rad, pic) files.

Deadlines

Form teams and select space – Wednesday, 27th August

Interim Project Submission – Monday, 13th October, 23:59hr

Final Project Report – Friday, 7th November, 23:59hr

Evaluation criteria for the project:

- Demonstration of familiarity with lighting concepts and performance issues
- Clarity of the project's objectives and strategies
- Soundness of the selected methodology
- Systematic application of performance metrics (quantification) and methodologies
- Use of Ecotect/Radiance for design analyses and presentations
- Coherence of the conclusions/results
- Effectiveness and innovativeness of design for the purpose of the space
- Organization, clarity, and expressiveness of report

Week	Date	Location	Topic	Objective	Project Schedule	University Calander
1	25-Aug	DH A310	Introduction	Overview of lighting and acoustics in architecture, project requirements	Project requirements	
	27-Aug	DH A310	Lighting Physics 1	Photometry- quantification of light.	Register project group and space	
2	1-Sep		-	-		Labor Day
	3-Sep	Hunt	Ecotect Demo	Software demo, basic modeling and process	Modeling exercise in Ecotect	
3	8-Sep	DH A310	Lighting Physics 2	Photometry- quantification of light.		
	10-Sep	Hunt	Ecotect Demo	Software demo, lighting analysis	Lighting analysis exercise in Ecotect	
	Recitation	CFA 214	Worksheet: Physics	Flux, Intensity, Illuminance, Luminance		
4	15-Sep	DH A310	Lighting Equipment	Color and electric lighting, polar curves		
	17-Sep	DH A310	Lighting Performance 1	Visual Performance, Contrast, CRI		
	Recitation	CFA 214	Worksheet: Physics & Sources	Polar Curves		
5	22-Sep	DH A310	Quiz 1	Photometry, lamp types, polar curves		
	24-Sep	Hunt	Ecotect Demo	Software demo, radiance analysis	Lighting simulation in Radiance	Mini-1 Course Drop and Pass/Fail Grade Option Deadline
	Recitation	CFA 214	Worksheet: Visual Performance	Contrast		
6	29-Sep	DH A310	Lighting Performance 2	Uniformity and distribution, VCP, UGR		
	1-Oct	Hunt	Ecotect Demo	Software demo, lighting analysis	Calculating glare using Ecotect/Radiance	
	Recitation	CFA 214	Worksheet: Performance Metrics	UGR		
7	6-Oct	DH A310	Lighting Design & Benchmarks 1	Design approaches		
	8-Oct	DH A310	Lighting Design & Benchmarks 2	LEED Credit 8.1 and 8.2, ASHRAE 90.1		
	Recitation	CFA 214	Worksheet: Design approaches	Quantitative & qualitative approaches, DL Factors		
8	13-Oct	DH A310	Quiz 2	All lectures	Project Interim Due	Mini-1 Course Drop Deadline to Receive a Withdrawal Grade, Last Day of Classes
	15-Oct		-	-		
11	7-Nov		-	-	Project Report Due	
17	18-Dec		-	-	-	Final Grades due by 6pm

LIGHTING REFERENCES

IESNA Publications

[IESNA Lighting Handbook 9th Edition](#). Illuminating Engineering Society of North America, 2000.

American National Standard Practice for Office Lighting. The Illuminating Engineering Society of North America, 2004.

IESNA /NALMCO Recommended Practice for Planned Indoor Lighting Maintenance. The Illuminating Engineering Society of North America, 2004.

Daylighting. IES RP-5-99. The Illuminating Engineering Society of North America. 1999.

The Lighting Design Process DG-7-94. The Illuminating Engineering Society of North America 1994.

IESNA Recommended Procedure for Determining Interior and Exterior Lighting Power. LEM-1-99. The Illuminating Engineering Society of North America 1999.

Books

[Daylighting Performance and Design](#). Ander, G. D. Van Nostrand and Reinhold, New York. 1995.

Daylighting. Hopkinson, R.G., P. Petherbridge, and J. Longmore. Heinemann, London. 1966.

[The Design of Lighting](#). Tregenza, P. and D. Loe. E and FN Spon. 1998.

[Light Revealing Architecture](#). Marietta S. Millet. 1996.

[ERCO Guide - Designing with light - Summary](#). Rugiger Ganslandt and Harald Hofmann. 1992

Reports / Papers

Gregg D. Ander.

Daylighting.

Whole Building Design Guide, <http://www.wbdg.org/resources/daylighting.php>. 12 May 2008.

Mahdavi, A. and L. Berberidou-Kallivoka.

GESTALT: A Prototypical Realization of an Open Daylighting Simulation Environment". Proceedings of the Illuminating Engineering Society of North America Annual Conference, held in Houston, Texas. August 8-12, 1993: pp. 104-120.

Ullah M.B.; Tan Kurniawan J.; Khee Poh L.; Kwok Wai T.; Tregenza P.R.

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Arnold.