COURSE OUTLINE

Description

This course continues the exploration of the luminous and thermal environments by extending the design considerations to include lighting, HVAC and utility system consideration, acoustics, and the implications of all of these on sustainability. The course addresses mechanical, electrical and utilities systems selection and design; energy cost avoidance; energy code requirements; and sustainable architecture.

Objectives

The objectives of this course are to teach the student to understand:

- thermal and lighting performance in architecture;
- methods for selecting thermal and electric lighting systems;
- fundamentals of economic analysis for selection of energy systems;
- implications of energy codes on building design;
- fundamentals of life-cycle cost analysis for building systems;
- basic electrical systems employed in buildings;
- fundamentals of electric lighting systems;
- fundamentals of plumbing systems;
- fundamentals of electrical systems;
- fundamentals of architectural acoustics;
- fundamentals of vertical transportation.

Teaching Philosophy

The built environment acts as the students' own living learning laboratory and provides a means to integrate course concepts into explorations in studio and professional practice. Lectures and readings form the foundation of the course. Recitations allow for a discussion and deeper exploration of specific course materials and concepts which typify situations that an architect encounters in practice. Projects are designed to sensitize students to the past, present, and future built world and how proven concepts of environmental control and sustainability can be integrated into the built environment.

Student interaction forms an important part of my teaching philosophy. The questions and the resulting discussions bring significant vitality to the course. Students are strongly encouraged to proactively ask questions to initiate discussions as well as seek clarity on materials presented in the lecture and recitations.
Outside the classroom, it is expected that students will also seek further inquiry that fosters the formation of their life-long learning skills. This includes completing class readings before each lecture, investigations at the library and other resources, working in study groups, and consultations with the teaching assistant and the instructor.

**Organization**

**Class Hours** Lectures will be 8:35-10:30 AM, in Room 127 AAC as indicated on the syllabus. There will be a recitation period on 2:00-5:00 PM on Tuesdays in Room 127. Desk Crits and examinations will be in the 3rd floor studio.

**Instructor/Office Hours** Robert A. Young, PE; 581-3909; young@arch.utah.edu; Room 240 AAC, MW 10:30-11:30 AM; or by appointment.

**Teaching Assistant** Brian Hebdon will be available for consultation outside of the classroom for questions and will assist in grading.

**WebSite** Students should periodically consult the instructor’s website [www.arch.utah.edu/young](http://www.arch.utah.edu/young) for updates on assignments and other course information.


Selected readings are on the class website or on reserve at Marriott Library. Refer to "Reserve Readings" section below for titles. Other readings will be added as needed.

**Recitation** There will be a recitation period on Tuesdays from 2:00-5:00 PM. The recitation will meet in Room 127 AAC, the third floor studio, Bailey Hall, or at site visit locations as described in the course schedule. Recitations will be composed of interactive exercises, site visits, discussions and review of course materials, release time, or studio consultations for projects.

**Decorum & Attendance** Punctuality, professionalism, and leadership are valued by clients, employers, colleagues, and faculty. As such, students should be ready to begin class at the scheduled start time and be prepared to ask and answer questions. Pagers and cell phones must be turned off or set to non-audio mode. Do not eat in class.
Class begins with announcements and questions to and from the class and the resultant discussions. Participation goes beyond just coming to class and taking notes. Leaders ask questions and seek clarity to foster greater understanding for themselves and for the class. Leaders engage the class in learning course materials both inside and outside the classroom.

Due to the quantity of materials covered, it is recommended that students attend class lectures regularly, ask questions, and keep up with the reading. Students’ participation and leadership qualities in class lectures, recitations, and projects will be used in consideration of their final course grade.

Projects These projects must be submitted to meet the course completion requirements:

(1) Electric Light Fixture Project
(2) Technology Integration Studio Project

Students are responsible for all in-class instructions on projects. Unless otherwise stated, projects are due by the start of class on the day they are due.

Project grades will be based on completeness, accuracy, technical comprehension, legibility, and originality. See grading form on the website for further information.

Late Policy Late work will be penalized one full letter grade (e.g., an "A" will become a "B", etc.) for any part of the first calendar day and one full letter grade per day thereafter. All unsubmitted late work must be turned in by 5:00 PM on the last day of the regular semester classes (not finals week) to receive completion credit even though it may be too late for a letter grade.

Examinations Examinations will be given in the third floor design studio and will be completed during the regular class period. The open book and open notes examinations will cover all readings, recitations, site visits, case studies, discussions, and lecture materials. Bring a #2 pencil, and a calculator. Questions should be answered on the grading sheet. Answer sheets and examinations must be
turned in at the end of the examination. Students should leave when done so others may finish the exam undisturbed.

Results will be posted at a minimum of 48 hours after all students have taken the examination.

Arrangements for students with learning difficulties should be made prior to the examination. Makeup examinations will only be given for medical or legal related reasons. Students arriving late will be penalized for their tardiness (e.g., no extra time).

Children, pets, and guests are not allowed during the examination. Do not eat during the exam.

Grading

Final grades will be based on the following credit:

<table>
<thead>
<tr>
<th>Item</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Lighting Fixture</td>
<td>100</td>
</tr>
<tr>
<td>Studio Integration Project</td>
<td>200</td>
</tr>
<tr>
<td>Examinations (2 @ 150 points)</td>
<td>300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>600</strong></td>
</tr>
</tbody>
</table>

Grades will be based on these cut off percentage points:

- A: 93
- A-: 90
- B+: 87
- B: 83
- B-: 80
- C+: 77
- C: 73
- C-: 70
- D+: 67
- D: 63
- D-: 60
- E: <60

Accessibility

The University of Utah College of Architecture + Planning seeks to provide equal access to its programs, services, and activities for people with disabilities. Reasonable prior notice is needed to arrange accommodations.

University Curriculum

Last day to drop (delete) classes: January 24, 2011

Administration Notes

Last day to add classes: January 27, 2011
## SCHEDULE

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Page Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 M</td>
<td>Course Introduction {1} ................................</td>
<td>SR-1</td>
</tr>
<tr>
<td>11 T</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>12 W</td>
<td>Lighting-2 {3}</td>
<td></td>
</tr>
<tr>
<td>17 M</td>
<td><strong>Martin Luther King Holiday – No Class</strong></td>
<td></td>
</tr>
<tr>
<td>18 T</td>
<td>Light Fixture Consultations</td>
<td></td>
</tr>
<tr>
<td>19 W</td>
<td>Lighting-3 {4}</td>
<td></td>
</tr>
<tr>
<td>24 M</td>
<td>Lighting</td>
<td></td>
</tr>
<tr>
<td>25 T</td>
<td>Recitation ...............................................</td>
<td>SR-2</td>
</tr>
<tr>
<td>26 W</td>
<td>Heat Flow {5}</td>
<td>171-209, App. E-G</td>
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<tr>
<td>31 M</td>
<td>Heat Flow {6}</td>
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<tr>
<td>February</td>
<td></td>
<td></td>
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<tr>
<td>1 T</td>
<td>Light Fixture Consultations</td>
<td></td>
</tr>
<tr>
<td>2 W</td>
<td>Heating/Cooling Loads {7} ................................</td>
<td>211-258, 277-287</td>
</tr>
<tr>
<td>7 M</td>
<td>Heating/Cooling Loads {8} ................................</td>
<td></td>
</tr>
<tr>
<td>8 T</td>
<td>Light Fixture Consultations</td>
<td></td>
</tr>
<tr>
<td>9 W</td>
<td><strong>Class Trip to Chicago</strong></td>
<td></td>
</tr>
<tr>
<td>14 M</td>
<td>Mechanical Systems: Elevators {9} ....................</td>
<td>1375-1442</td>
</tr>
<tr>
<td>15 T</td>
<td>Recitation ...............................................</td>
<td>SR-3&amp;4</td>
</tr>
<tr>
<td>16 W</td>
<td><strong>Examination #1</strong></td>
<td></td>
</tr>
<tr>
<td>21 M</td>
<td>** Presidents’ Day – No Class**</td>
<td></td>
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<tr>
<td>22 T</td>
<td>Light Fixture Consultations</td>
<td></td>
</tr>
<tr>
<td>23 W</td>
<td>Mechanical Systems: HVAC {10} .......................</td>
<td>317-455</td>
</tr>
<tr>
<td>March</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 T</td>
<td><strong>Lighting Fixture Exhibition</strong></td>
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</tr>
<tr>
<td>2 W</td>
<td>Electric Lighting Project Due by 2:00 PM.</td>
<td></td>
</tr>
<tr>
<td>7 M</td>
<td>Plumbing Systems-1 {13} ................................</td>
<td>855-1045</td>
</tr>
<tr>
<td>8 T</td>
<td>Studio Consultations</td>
<td></td>
</tr>
<tr>
<td>9 W</td>
<td>Plumbing Systems-2 {14}</td>
<td></td>
</tr>
<tr>
<td>14 M</td>
<td>Plumbing Systems-3 {15}</td>
<td></td>
</tr>
<tr>
<td>15 T</td>
<td>Recitation ...............................................</td>
<td>SR-5</td>
</tr>
<tr>
<td>20 W</td>
<td>Acoustics {16}</td>
<td>727-852, App. K,L</td>
</tr>
<tr>
<td>21-25</td>
<td><strong>Spring Break</strong></td>
<td></td>
</tr>
</tbody>
</table>

1 Number in brackets {} after lecture title corresponds to the lecture number found on class website.
### Date | Topic | Page Ref
--- | --- | ---
March 28 M | Acoustics {17} | SR-6
29 T | Studio Consultations | 
30 W | Acoustics {18} | 
April 4 M | Acoustics {19} | 
5 T | Recitation | SR-7
6 W | Examination #2 | 
11 M | Studio Consultations | 
12 T | Studio Consultations | 
13 W | Studio Consultations | 
18 M | Studio Consultations | 
19 T | Studio Consultations | 
20 W | Studio Consultations | 
25 M | Studio Consultations | 
26 T | Studio Consultations | 
27 W | Studio Consultations | 
| **All unsubmitted late assignments due by 5:00 PM** | |
May 1 M | Integration Project due: TBD | 

### SUPPLEMENTAL READINGS
- SR-1 ARCH-4372/6372 Course pack
- SR-2 Lighting Worksheet
- SR-3 Heating and Cooling Load Calculation Forms
- SR-4 Heat Flow Worksheet
- SR-5 Plumbing Worksheet
- SR-6 Acoustics Supplement
- SR-7 Acoustics Worksheet

### REFERENCE LIST (SELECTED)


Wigginton, Michael and Jude Harris. *Intelligent Skins*, Oxford, ENG: Butterworth Heineman, 2002
ELECTRIC LIGHTING FIXTURE

Introduction

This project is an opportunity to design light fixtures using standard components as an architectural expression. Electric lighting can use architectural elements drawn from the vocabulary of a building itself to provide illumination to a given space. Safety requirements that dictate fixtures must satisfy conditions for safety from overheating and potential injury from handling the lamp are of utmost importance for this project.

Objectives

The objectives include:

- To enhance visual analysis skills.
- To enhance understanding of light fixture design and construction.
- To design a point source light fixture.

Procedure

Design a point source light fixture based on your design parti for this semester’s studio project. The lamp within the fixture should not be visible when in use. Attention to glare and the appropriate cut off angles should be considered as integral to the basic design. In preparing the design, ask yourself the question “Would someone pay an architect to design this light fixture rather than simply buy it from a local distributor?” If you can not answer this affirmatively, then you should continue refining the design until you can.

Advisory Note: The best lighting fixture projects from previous classes were created by students who began their design (and fabrication process) several weeks prior to the submission deadline. A number of students who waited until 2-3 days prior to the deadline later expressed regrets about not spending more time developing their designs earlier, particularly when compared with students who had. So begin planning the design of this fixture several weeks ahead of time, even if the actual final fabrication and photometric analysis portion of the project occurs just prior to the deadline. The instructor will be available for desk consultation as noted in the syllabus and office hours. Also keep in mind that there are only a limited number of light meters available so waiting until the last minute to do the photometric measurements is not advisable.

Good lighting fixtures provide a well designed composition of elements that safely meets performance requirements and adheres to budget constraints. For this project a 60W incandescent lamp is suggested to keep costs down. However, more expensive lamps (e.g., compact fluorescents, LED) may be used.
as students’ economic situation allows. Although the impulse to use high end materials and components may tempt you to spend a significant amount of money, **the raw materials and components for the finished light fixture should cost no more than $50**. With careful attention to materials and components, the project can be successfully completed for significantly less than that amount. The reuse of “found” or recycled materials is encouraged.

Components such as transformers for low voltage lighting systems, touch sensitive switches, LED components, and fiber optics can be expensive and may require a lead time (e.g., 5 or more business days for normal delivery) if ordered from online distributors. If you are ordering components online, allow for the lead time needed for their delivery.

Keep it simple! One useful approach is to understand the fixture as a collection of smaller pieces arranged into a larger composition. This is the basis of the paper and wood fixtures available at popular contemporary furniture stores.

Suggested materials include paper, balsa wood, tinfoil, glue, and paint. You are welcome to explore other materials, such as glass, metals, plastics, and recycled/found objects. Although in practice lighting fixtures can be wired into an electrical system and controlled by a light switch, for this project, all fixtures must have an on/off switch and be able to be plugged into a standard wall receptacle.

The fixture should be vented to allow heat from the lamp to escape. To reduce fire hazard, materials should not touch the lamp. Above all, unless you intend to develop an appropriate structural support system, keep it lightweight.

The light fixture should either sit on a table top or be suspended from the ceiling. Students who wish to design a surface mounted lamp will need to fabricate their own individual mounting and testing surface. Fixtures must be assembled from "scratch" and not simply consist of a reused fixture, although components from other fixtures may be salvaged and reused. **The finished fixture, when fully assembled, must be operable and fit within a 24” cube. Failure to do so will penalize the project up to one full letter grade for each missed requirement.**

The fixtures will be evaluated based on visual comfort attributes (glare elimination and functionality), accuracy and presentation of specification sheet, quality of craftsmanship, safety, functional operation, maintainability, and design aesthetics. Fixtures should be designed to withstand the heat of the lamp so as not overheat, melt, burn assembly materials, or surrounding surfaces. Fixtures should include precautions for safety (e.g., no sharp or jagged edges, or pointed protrusions which may injure the user).

Having assembled the light fixture, develop the description and specifications used in the marketing of commercial lighting fixtures. Measurement of the lamps should be made in a room with no exterior light sources. Ideally the floors, walls, and ceilings should be dark to minimize the unwanted effects of light reflected.
from these surfaces. You should place your fixture so that the light source has a minimum 42 inch clearance to allow light measurement. Your objective is to make a series of seven light meter readings with the light meter sensor aimed at the light, each at a distance of 36 inches from the center of the lamp. For suspended fixtures, the first should be with the light meter directly above the fixture with the sensor aimed down; the last should be directly below the fixture with the sensor aimed up. Intermediate readings should be made at the 30 degree increments with the meter sensor aimed at the center of the light. For table-top and surface-mounted fixtures begin on one side of the fixture and complete the seven readings in 30 degree increments until completing the 180 degree arc.

Calculate the candlepower (CP) at each angle increment using the following formula:

\[ CP = fc \times D^2 \]

where:

- CP = candlepower
- fc = meter reading in foot-candles
- D = distance from center of light source to meter, in feet.

For example, if a reading of 130 fc was taken with the meter 36 inches from the center of the light, the candlepower \( CP = 130 \times (3)^2 = 1170 \).

Graph the CP of your lamp on the photometric chart. In the specification sheet for surface mounted fixtures, orient the photometric curve to indicate the surface orientation relative to the light fixture. Be sure to scale your graph by labeling the CP circles on the graph. The single-page, single-sided (8-1/2" x 11") specification form should include:

1. Designer: your name
2. Name of Lamp
3. A photo of your lamp.
4. Specifications/Description: this is to be a verbal description of the lamp, the resulting light characteristics, and possible applications.
5. Section and Dimensions: include a clear, simple line drawing of the lamp in section with dimensions noted.
6. CP photometric distribution curve.

**Product**

For the lighting exhibit, prepare a 1-3 minute oral presentation of how the fixture represents your studio project parti and how the fixture will be used in the building. Use the template provided below as the guide for the specification sheet so that the class projects can be compiled into a catalogue. You are encouraged to make it a more powerful presentation through the use of color,
computer graphics, etc. Submit your fixture along with one "original" and one copy of your specification sheet for comments. The original will be retained by the instructor and the copy and fixture will be returned to you. On a CD, include a copy of the specification sheet file and a photo of your fixture that will be considered for inclusion in the class gallery on the College website.

**Grading Criteria**

The specification sheet must include the required components given above. The fixture will be graded on design creativity, functionality (the lamp must be operable and produce the desired light for its intended purpose), safety considerations, utility considerations (switch location, ease of changing the lamp), design integration of components (coordination of color/materials, cord color, cord switch or other switch type).
TECHNOLOGY INTEGRATION PROJECT

Introduction

It is critical to integrate environmental control technologies into designs to enhance the quality of life and mitigate the depletion of natural resources. Using architectural form as an environmental control system is a fundamental practice that enhances environmental awareness and sensitivity towards sustainability.

Objective

The objective is to enhance the student’s ability to integrate luminous, thermal, mechanical-electrical-plumbing (MEP), and acoustical systems.

Procedure

The student will use the final studio project to demonstrate her or his ability to integrate the concepts covered in environmental systems/technology integration courses. The student will consult with the instructor to develop the sustainable design strategies using studio consultations as noted on the syllabus. There will be a sign-up sheet posted. Students who have not previously signed up prior to a studio consultation session period will be seen only on a time-available basis. The student will integrate the environmental control strategies into the drawings, images, and models required for the studio presentations and juries. Concepts should be clearly articulated and readily legible. The student is encouraged to add “vignette” drawings and sketches to explain environmental control concepts directly. The students must prepare a summary (8-1/2 x 11 format, 12-15 pages long) to describe the integrated concepts. It is expected that the primary images used in the summary will come directly from the drawings, animations, and other images used in the student’s final presentation.

Product

Two versions of the summary should be submitted on a CD. One shall be in its native format (e.g., .doc, .ppt) and one shall be a .pdf version of the original. All environmental strategies must be legible. Turn in the CD to the instructor as noted in the syllabus.

Grading Criteria

Grades will be based on integrating environmental controls as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daylighting</td>
<td>40</td>
</tr>
<tr>
<td>Mechanical</td>
<td>30</td>
</tr>
<tr>
<td>Microclimate/Regional Vernacular</td>
<td>20</td>
</tr>
<tr>
<td>Utilities/Acoustics</td>
<td>10</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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</table>