Syllabus

ARCH 6531
Environmental Systems I
Spring 2015

(*note: material distinct from the undergraduate version of this course is indicated in red text.*)

Course Info.
3 credit hour lecture
TBD
TBD

Instructors
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Required text
Grondzik, et al., **Mechanical and Electrical Equipment for Buildings**, 11th ed. (2010), J. Wiley, Hoboken, NJ

Supplemental readings
Steven V. Szokolay, **Introduction to Architectural Science: The Basis of Sustainable Design**, 2nd ed. (2008), Architectural Press/Elsevier, Burlington, MA
This is an optional text

Supplementary handouts will also be provided.

Overview and Outcomes
ARCH 6531 focuses on basic physical interactions between buildings, their surroundings, and occupants. Specifically: three key types of energy flows in buildings, their impact on building occupants, and their influence on design decisions. Toward that end, the following topics will be discussed:

I. **(Natural) light**
   i. Physics of light
   ii. Natural illumination (daylighting and some solar geometry)
II. **Acoustics in buildings**
III. **Thermal sciences for buildings**
   i. Basic thermodynamics and heat transfer
   ii. Psychrometrics and thermal comfort
   iii. Solar geometry and the control of direct solar radiation through shading devices
   iv. Load calculation
   v. A few special topics

This course is required for the professional Master of Architecture (M Arch) degree. ARCH 6532 is the companion to this course and is also required for the M Arch degree. Whereas 6531 considers passive energy flows, 6532 focuses on active systems for thermal control (HVAC) and lighting (artificial lights) as well as electrical systems, plumbing, elevators, some fire safety, etc.

Overview and Outcomes

The learning outcomes of this course are:

1. **Develop the ability to reason through, model, and analyze a technical problem in the three topic areas listed above**
   We will investigate the fundamental laws and models describing the aforementioned topics/physical processes, and most importantly, what these laws and models *mean*. Using the knowledge and comprehension thus acquired, we will apply these models to particular situations. In some cases these basic, fundamental models will need to be adapted and/or combined to form an appropriate and useful model; this new model may be simpler or more complex. This modeling activity is distinctly different from the sort of modeling done in the architectural studio, but both are ultimately done in the service of design – although one is technical design and the other is 'Design', they can, and should, be complimentary.
2. **Apply models to interrogate the effects of physical processes on basic design parameters**
   The *use* of these models will allow you to make more informed design decisions regarding technical matters.
3. **The formation and use of a systems level model to aid design decision-making**
   The individual topics of this class do not exist in silos, isolated from one another. They are interrelated in several ways and impact not only each other, but also impact multiple facets of a building design. These interrelations are made explicit in system-level models. They may lead to conflict among the objectives of a design, or lead to a complimentary relationship among objectives. The ability to comprehend and manage these interrelations at the whole system level, i.e. make design tradeoffs, is something that any designer of a real system will need.

In addition I hope that you will develop intuition and a tough, skeptical habit of mind. The world does not always operate the way we might expect, and misleading information abounds. A sense of context, the programming of your intuitive sense, and an innate resistance to being fooled will serve you both in design practice and all other walks of life.

To achieve these outcomes, elementary mathematics will be used throughout the course, although math is not the object of the course. Math is a tool and a language to precisely develop and express concepts (i.e. to model), for making predictions about the outcomes of technical design decisions (i.e. to execute that model), and thereby to explore the space of possible technical design solutions.

The lectures will cover material that may not be in your texts; lectures that do cover text material will not follow the presentation in the texts exactly. The texts are perhaps best thought of as supplemental to the lectures, as a reference for future practice, and as a study aid for your licensing exams. Some extra readings will be provided from time to time, and some of these will be more in line with the lectures, but it is nevertheless in lectures where the bulk of information will be given.

Overview and Outcomes

As a core course in the accredited Master of Architecture program, the following NAAB Student Performance Criteria from the 2014 NAAB Conditions for Accreditation are treated in this course:

1. **Ability: B.6 Environmental Systems**
   Ability to demonstrate the principles of environmental systems' design, how design criteria can vary by geographic region, and the tools used for performance assessment. This demonstration must include active and passive heating and cooling, solar geometry, daylighting, natural ventilation, indoor air quality, solar systems, lighting systems, and acoustics.
2. **Understanding: B.7 Building Envelope Systems and Assemblies**
   Understanding of the basic principles involved in the appropriate selection and application of building envelope systems relative to fundamental performance, aesthetics, moisture transfer, durability, and energy and material resources.
3. **Understanding: B.8 Building Materials and Assemblies**
   Understanding of the basic principles used in the appropriate selection of interior and exterior construction materials, finishes, products, components, and assemblies based on their inherent performance, including environmental impact and reuse.

In these criteria, *ability* and *understanding* mean the following, according to the NAAB 2014 Conditions for Accreditation:

1. **Ability**: Proficiency in using specific information to accomplish a task, correctly selecting the appropriate information, and accurately applying it to the solution of a specific problem, while also distinguishing the effects of its implementation.
2. **Understanding**: The capacity to classify, compare, summarize, explain, and/or interpret information.

Course Assignments and Evaluation

Grading Students will be evaluated on the basis of homework assignments and exams:

i. $\leq$ 7-10 homeworks - 40%
ii. Project - 10%
iii. 2 exams - 50%

Homework We will have between 7 and 10 homework assignments, and generally you will have a week to complete them, as each will take several hours to complete.

Project: You will be tasked with analyzing the thermal demand performance of a current or past studio project using a *normative* whole-building energy modeling tool, use the feedback from this tool to make design decisions that lower monthly and yearly thermal demand, and write a brief narrative explaining the decisions made. As such this project will fulfill the third learning objective listed above.

Exams There will be one midterm and one final exam. These will emphasize both analytical competency and conceptual understanding which you will build up through your effort in the homework and through class discussion. Both exams will be of open book/open note format; the final exam will not be cumulative.

You will be graded based on the correctness of quantitative answers where appropriate, although partial credit will be given if your work demonstrates some understanding of the material. Quizzes can be a special case in which an answer is either right or wrong with nothing in between. Note that a quantitative answer with a correct numerical value but incorrect or missing unit will be counted as incorrect. Five dollars is not five cents.

Submissions and makeup policies Homework is to be turned in at the beginning of class on the day it is due. If turned in between the time I begin the lecture and the end of class, it will be docked 10%. If it is turned in later that same due day, it will be docked 50%. No submissions will be accepted after the due day unless you have prior approval from me (emergencies excepted). If you are going to be absent for the midterm for a good reason, I will arrange a time for you to make up the exam or (preferably) take it early.

All assignments will be given a point value based on the difficulty and amount of work required. Your grade within a category will be based on the total points in that category and not on the percentage values of the individual assignments in that category. The weightings for each category are above.

The grade scale is:

Percentage	**Letter Grade**
90-100	A
80-89	B
70-79	C
60-69	D
0-59	F

Other Policies

Office hours: See above; do not hesitate to ask for help: it's my job. If the listed office hours are inconvenient, shoot me an email and I'll set up a time. Or try my office – if my door is open or cracked, I'm available. If it's closed I'm unavailable (don't even knock).

Academic integrity: Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please see The Georgia Institute of Technology 2012-2013 Catalog at http://www.catalog.gatech.edu/. Refer specifically to section XVIII entitled "Academic Honor Code" at http://www.catalog.gatech.edu/rules/1.php for the principles, policies, and procedures governing issues of academic integrity.

Collaborative work: I allow appropriate collaboration on homework assignments, but not on projects and (obviously) tests and exams. Here, 'appropriate collaboration' refers to, e.g. a group discussion that helps you understand and think through a problem and enables you to work the problem yourself; it **does not** mean others do the work for you. There is a fine line between appropriate and inappropriate collaboration, and I expect you to use your judgment on this matter. The guiding principle is that you must ultimately be able to do the work yourself, but collaboration that helps develop this ability is appropriate.

Accommodation of disabilities: Any student with a disability that may require accommodation should contact ADAPTS (Access Disabled Assistance Program for Tech Students) at (404) 894.2564 or http://www.adapts.gatech.edu/ to make an appointment to discuss his or her special needs and obtain an accommodations letter. He or she should also schedule an appointment to speak with the instructor.

Emergencies: In case of emergency (e.g., fire, accident, or criminal act), please call the Georgia Tech Police at (404) 894.2500. Please note that Perry Minyard, IT Support Administrator for the College of Architecture, is also a firefighter and an Emergency Medical Technician (EMT) certified in performing CPR.

Changes to syllabus: With the exception of grading policies, parts of this syllabus may change as deemed appropriate by the instructor; you will be given notice of such changes in advance. The schedule is likely to change a little as the semester evolves, and important changes such as due dates or dates of tests and exams will be announced.

Representative Schedule

ARCH 6531
Environmental Systems I
Spring 2013

Assignments are listed on the day they are given, not when they are due.

Week	Day	Date	Topic	Book Reading	Assignment
1	T	1/08	Introduction	Intro to units (handout)	'quiz' 01
	Tr	1/10	Light & vision	MEEB 11.1–11.12, IAS *2.1*	
2	T	1/15	Light & vision, daylighting	MEEB 11.15–11.29, 11.34–11.36, IAS *2.2, 2.3*	HW 01
	Tr	1/17	Daylighting	MEEB 12.1–12.6, Ch. 14 IAS *2.4*	
3	T	1/22	Daylighting		
	Tr	1/24	Daylighting, thermal intro.	IAS *1.2*	
4	T	1/29	Heat/thermodynamics – basics	MEEB Ch. 7, IAS *1.1.1, 1.1.2*	HW 02
	Tr	1/31	Basic thermodynamics		
5	T	2/05	Basic thermodynamics		HW 03
	Tr	2/07	Basic thermo, psychrometrics		
6	T	2/12	Psychrometrics, thermal comfort	IAS *1.1.3, 1.2*	HW 04
	Tr	2/14	Psychrometrics, thermal comfort		
7	T	2/19	Review		
	Tr	2/21	Midterm Exam		

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Assignments are listed on the day they are given, not when they are due.

Week	Day	Date	Topic	Book Reading	Assignment
8	T	2/26	Midterm review		
	Tr	2/28	Heat transfer: conduction		Project
	F	3/01	*Drop Day*		
9	T	3/05	Heat xfr.: conduction & convection		
	Tr	3/07	Heat xfr.: convection & radiation	IAS *1.4.1.3*	HW 05
10	T	3/12	Radiation & composite construction	IAS *1.5*	HW 06
	Tr	3/14	Thermal properties of composite constructions		
11			Spring Break		
12	T	3/26	Composite constructions cont'd.		HW 07
	Tr	3/28	Bldg. energy demands, solar geometry	MEEB 6.1–6.4, IAS *1.3.1*, handout	
13	T	4/02	Solar geometry	MEEB 6.5, IAS *1.4.1*	
	Tr	4/04	Shading		HW 08
14	T	4/09	Shading, climate		
	Tr	4/11	Climate, acoustics	MEEB Ch. 17, IAS *Ch. 3*	HW 09
15	T	4/16	Acoustics	MEEB Ch. 18 19.1–19.13	
	Tr	4/18	Acoustics		
16			Final Reviews: No Class		
	M	4/29	Finals		
	T	4/30	**Final Exam: 8:00a – 10:50a**		
17	W	5/01	Finals		
	Tr	5/02	Finals		
	F	5/03	Finals		