SYLLABUS -- ARCH 6251 – Building Structures I

Learning Objectives

This course provides an introduction to the analysis and design of building structures – and the ordering of structural systems to resist gravity loads. This course and its follow-on course (ARCH 6252) are requirements for the professional degree in architecture and as such focus on the core knowledge of building structures as contained in the Architectural Registration Exam (ARE) and as set forth by the National Architectural Accrediting Board (NAAB) in the *2014 Conditions of Accreditation*[1]. NAAB describes the technical competency expected of architects as related to building structures and materials as follows:

> *A.5 Ordering Systems:* **Ability** to apply the fundamentals of both natural and formal ordering systems and the capacity of each to inform two- and three dimensional design.
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> *Realm B: Building Practices, Technical Skills, and Knowledge.* Graduates from NAAB accredited programs must be able to comprehend the technical aspects of design, systems, and materials and be able to apply that comprehension to architectural solutions. In addition, the impact of such decisions on the environment must be well considered.
>
> *B.5 Structural Systems:* **Ability** to demonstrate the basic principles of structural systems and their ability to withstand gravitational, seismic, and lateral forces, as well as the selection and application of the appropriate structural system.
>
> 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.

The specific objectives of Building Structures 1 are as follows:

- To introduce the mathematics and physics that govern the structural analysis and design process: external and internal equilibrium, stability, free body diagrams, internal force diagrams.
- To introduce the concept of stress and strain – the mapping functions between material possibility and structural requirements for load and deformation capacity.
- To introduce you to the structural design process: geometric synthesis → structural idealization → load identification → load rundown → structural analysis → structural design;
- To familiarize you with reading and creating typical structural framing schema in wood structures;
- To review and expand your knowledge of solid structural materials; to define what constitutes a “structural” material and to quantify the architectural, mechanical, thermal, and environmental properties of these materials;
- To introduce you to the wood products used in residential and commercial buildings — both common dimensional lumber and the so called engineered wood products and wood composites;
- To introduce structural design in wood using allowable stress design for tension members, compression members, and flexural members.
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In addition to its technical role, the course content complements architectural studio by focusing on the form-giving and construction-technology aspects of building structures.

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1 http://www.naab.org/accreditation/2014_Conditions

Textbook and References

required text:

Statics and Strength of Materials for Architecture and Building Construction, 4th Edition (2011), by Onouye and Kane

reference texts:

Building Structures, 2nd Edition (1993) by James Ambrose

Fundamentals of Building Construction 6th Edition, 2013 by Edward Allen

Building Construction Illustrated, 5th Edition (2011) by Francis Ching

Structures, by Daniel Schodek and Martin Bechthold, Prentice Hall , 7th Ed., 2013

Origins of Form, Christopher William, 1995

National Design Specification for Wood Construction (w/ Design Supplement), American Forest and Paper Association.

Minimum Design Loads for Buildings and Other Structures, ASCE 7-10, American Society of Civil Engineers, 2005.

U.S. Span Book for Major Lumber Species, 1999 Edition, Canadian Wood Council.

Steel Roof and Floor Deck, Vulcraft.

Steel Joists and Joist Girders, Vulcraft.

Wood Construction Connectors, Simpson Strong-Tie Company.

Homework

The GTA will grade the homework and post solutions on t-square. Each homework will be assigned a due date. Homework must be turned in on time to receive a grade — *late homework will not be not be accepted.* The lowest homework grade will be dropped (but note that it is possible that one or two key homework assignments will be critical to the course and must be completed). Homework must be neat and well laid out. Your logic should be easy to follow. Use a straight edge, underline intermediate answers, and box your final answers. Homework grades will be based on neatness, presentation and completeness of work, and inclusion of required information. Most homework assignments will be submitted in hand-written, hard-copy format, but a few may be submitted as a single PDF, uploaded to t-square.

Laboratory

The architectural structures courses are listed as two hours of lecture with a three hour lab each week (3/2/3 in GT lingo). The purpose of the laboratory is to allow us to hold more in-depth discussions than are possible in hour-long lectures. In general, the laboratory period will not be used for the presentation of new material. Specifically, the laboratory period will be used for:

- presentation and discussion of case studies,
- demonstration of structural simulation computer software,
- materials demonstrations,
- completion of team and individual lab projects
- field trips, and
- exam preview and review.

The laboratory will contain an in-class component and an out-of-class component.

Projects
The laboratory projects will be completed in groups of three to five students. I will select the groups. In the first project you will describe a structure in Atlanta in a verbal and pictorial narrative – “a structural reading”. This short project will be completed early in the term.

Students enrolled in the graduate section of the course are expected to participate in the group structural readings exercise, and then complete an individual project using the same methodology. The students will complete a structural reading on a notable building of their selection, with the approval of the professor. As precursor to the exercise, the graduate students should complete a set of readings, to include as a minimum:

> Guy Nordenson, “Collaboration” Perspecta 31: Reading Structures, Yale Architecture Journal, New Haven CT 2000.
>
> Peter Rice, An Engineer Imagines, Artemis 1998, “Early Life” and one other chapter describing one of Rice’s buildings.

Grading
The hourly quizzes will be announced at least one week in advance. They are preliminarily scheduled in the course outline below. Grades on the exam will not be curved. I reserve the right to shift exam grades if I deem that the test was too difficult or too long to complete in the allotted time. Course credit is distributed as follows:

Assignment	**UGrad**	**Grad**
Homework	15%	15%
Attendance/Participation	5%	5%
Structural Readings Exercise	10%	10%
Structural Readings Exercise (graduate students only)		10%
Hourly Quizzes (2)	40%	30%
Final Exam	30%	30%
Total	**100%**	**100%**

Attendance Et Cetera
If you are to do well in this class, you must attend. Much of the information needed to complete the course will come from my lectures and handouts. Absence from class is not considered a valid excuse for not turning in your homework. If you have a problem that prohibits your participation, you must let me know beforehand. Students who are chronically absent or are repeatedly late to class will lose the participation component of their final grade.

Students with special needs that are administered by the Dean of Students or by the ADAPTS office should contact the appropriate office and inform me at the start of the term so that I can ensure that we accommodate you to the fullest degree possible.

Construction of laboratory projects for this class may be completed in the Digital Fabrication Laboratory and CoA if you have completed the safety training course offered by the shop supervisor. Students who abuse their shop privileges by ignoring safety procedures, by neglecting to clean up after themselves, or by leaving material in the shop without permission will be asked to complete their course projects elsewhere.

Honor Policy and Academic Conduct

It is expected all homework assignments will be completed solely by the student. It is appropriate to seek guidance from your classmates as to the way in which they tackled an individual assignment - it is not appropriate to copy from others. For research and writing assignments, it is critical that all references, including web sites, be identified in footnotes or a bibliography. Note that it is improper to cut and paste text from web documents and represent it as your own work. You are expected to abide by the provisions of the Georgia Tech Honor Code. Details of this policy are found at: http://www.honor.gatech.edu.

Preliminary Schedule

We will follow the preliminary schedule presented below. The suggested readings and references for the course are assigned in the schedule below, by chapter. Additional readings may be assigned during the term. Text abbreviations are as follows:

SSM = Statics and Strength of Materials by Onouye and Kane
ASCE7 = Minimum Design Loads on Buildings and Other Structures (ASCE-7)
BS = Building Structures

FBC = Fundamentals of Building Construction
AISC = American Institute of Steel Construction, Steel Manual
DS = Structures, by Schodek and Bechthold
BCI = Building Construction Illustrated
OF = Origins of Form

Week		Lecture Topics / Reading	Laboratory / Homework
1	8/17	Structural Typologies and Topologies **SSM,** Chapter 1, **DS**, Chapter 1 **OF,** Chapter 1: Form and Matter Chapter 2: Struts and Ties-The Elements of Structure	
2	8/24	Mathematics of Structural Analysis Loads on Structural Frames + Self-Weight of Building Assemblies, Tributary Area Analysis Vectors	HW #1: Load Rundowns, Vectors
3	9/1	Structural Material Properties Stress, Strain, Force Displacement Introduction to Wood Materials	Lab Demonstration
4	9/8	Forces and Moments External Equilibrium **SSM** Chapter 2 plus **SSM** Sections 3.1 and 3.2	HW #2: External Equilibrium
5	9/15	Free Body Diagrams Internal Equilibrium	
6	9/22	Internal Equilibrium: Axial Forces, Stresses and Strains. Elongation. Tension and Compression.	HW #3: Axial Force Members, Catenary Members
7	9/29	Axial Stability, Euler Bucking	HW #4: Buckling
8	10/5	Internal Equilibrium of Beams, Bending and Shear Stresses, Bending and Shear Diagrams	HW #5: Shear and Moment Diagrams
9	10/12	Shear and Moment Diagrams Deflection of Beams	
10	10/19	Computer-Based Analysis of Structures See : http://www.iesweb.com/training/index.htm	HW #6: Computer Analysis of

			Structures **Structural Reading Assignment, Assigned**
11	10/26	Wood Members, Sawn Timber, Structural Wood Composites	
12	11/2	Framing Plans in Wood. Use of Span Tables.	HW #7: Framing Plans in Wood Buildings
13	11/9	Allowable Stress Design Methodology, Design of Flexural Members **SSM** 6, 7; **DS** 6; **BS** 17, 22.	HW #8: Design of Wood Beams
14	11/16	**Structural Readings (presentations)**	
15	11/23	**Wood Trusses**	HW #9: Design of Wood Trusses
16	12/2	No Class - Final Jury Week	
17	12/9	Final Exam Week	