# ARCH 6016 – Building Structures II Spring 2018

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| Instructor: Russell Gentry  email: [russell.gentry@coa.gatech.edu](mailto:russell.gentry@coa.gatech.edu)  Class Schedule: T Th, 9:30 to 10:45 a.m.  Office: Th 10:45 a.m. to noon or by appointment | TA: Leila Mohimi  ES&T Building L1205 |

**Learning Objectives**

This course is a requirement for the professional degree in architecture and as such focuses on the core knowledge of building structures as contained in the Architectural Registration Exam (ARE). The prerequisite course, ARCH 6251 provide an introduction to structural analysis, structural material science and building structures constructed primarily of wood members. This course covers the design of building structures in structural steel and reinforced concrete, and the design of all building structures to resist lateral loads. The National Architectural Accrediting Board (NAAB) in the *2014 Conditions of Accreditation*[*1*](#_bookmark0)sets forth the following provisions for 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.

*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 II are as follows:

* To introduce the physical concepts of lateral load events (wind, earthquake, blast), to understand the physical principles of how these events are quantified in terms of loadings, and to introduce design concepts for lateral force resisting systems in buildings;
* To introduce structural design in structural steel using allowable stress design for tension members, compression members, and flexural members.
* To introduce cementitious materials: Portland cement, mortar, sand concrete, and normal concrete through descriptions of how Portland cement is manufactured, how it hydrates, and how it is combined with fine and coarse aggregates to make concrete;
* To describe the mechanical, thermal, and weathering properties of plain concrete and reinforced concrete in terms of both “engineering” units and in non-quantitative terms;

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

* To review the practical aspects of concrete construction: concrete mix design, formwork, shoring, rebar placement, concrete placement, finishing, and curing;
* To present the design of common reinforced concrete floor systems: concrete joist systems, one-way slabs, waffle-slabs, flat plates and flat slabs – and methods for integrating these systems into architectural design proposals;
* To review design of typical structural members of reinforced concrete: beams, columns, slabs, spread foundations and introduce the design and behavior of other concrete structural systems: pre-cast concrete, pre-stressed and post-tensioned concrete and load-bearing concrete masonry;

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.

# Textbook and References

The course does not have a required text. The following reference texts are recommended – we will assign readings in some of these during the semester.

*Reference texts:*

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

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.

Steel Roof and Floor Deck, Vulcraft. Steel Joists and Joist Girders, Vulcraft.

Design and Control of Concrete Mixtures, Portland Cement Association

ACI 318, Building Code Requirements for Reinforced Concrete, American Concrete Institute

# Homework

Approximately six homework assignments will be given during the semester. 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. 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. All calculations must be shown. Homework grades will be based on neatness, presentation and completeness of work, and inclusion of required sketches.

# Laboratory

The purpose of the laboratory is to allow us to hold more in-depth discussions than are possible in the lectures. In general, the laboratory period will not be used for the presentation of new material (unless we are making up for time missed in a regularly-scheduled class). Specifically, the laboratory period will be used for:

* presentation and discussion of case studies and worked problems,
* demonstration of structures computer software,
* materials demonstrations and labs,
* completion of lab projects
* field trips, and
* exam preview and review.

# Laboratory Projects

There will be one major laboratory projects during the term: a lateral load model project. Construction of laboratory projects for this class may be completed in the college shop if you have completed the safety training course offered by the college shop. 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.

# Grading

The hourly quizzes will be announced at least a week in advance. They are preliminarily scheduled in the course outline below. If you must miss an exam, you must inform me and complete a makeup exam *before* the scheduled date or receive explicit permission to take it later. I reserve the right to give the same exam or a different exam as a makeup, at my discretion. **The final exam can only be taken on the assigned date, so do not plan to leave campus before the final.**

Course credit is distributed as follows:

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| Homework | 15% |
| Attendance and Participation | 5% |
| Lab Project | 10% |
| Hourly Quizzes | 45% |
| Final Exam | 25% |
|  | 100% |

# Academic Integrity and Conduct

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. All Georgia Tech students should familiarize themselves with and abide by the Georgia Tech Honor Code <http://www.catalog.gatech.edu/rules/18/>.

Student work that presents the ideas or words of others as the student’s own adversely impacts the whole school and may lead to immediate dismissal. Academic dishonesty, including cheating, plagiarism, commissioning academic work by others, or performing academic work on behalf of another student, is strictly prohibited. All persons in the classroom are expected to behave with courtesy towards others and in a way that does not interfere with the regular conduct of the class. Cell phones are to be turned off when students enter the classroom and should remain off for the duration of class: <http://www.catalog.gatech.edu/rules/19/>

# Special Needs

Any student with a disability, that may require accommodation, should contact Office of Disability Services at 404-894-2563 or visit <http://disabilityservices.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 course instructor.

# Preliminary Schedule

We will attempt to follow the preliminary schedule presented below. The readings for the course are assigned in the schedule below. Additional readings may be assigned during the term.

Text abbreviations are as follows:

ASCE7 = Minimum Design Loads on Buildings and Other Structures (ASCE-7) BS = Building Structures, Ambrose

BCI = Building Construction Illustrated, Ching

DCCM = Design and Control of Concrete Mixtures, Portland Cement Association FBC = Fundamentals of Building Construction, Allen

Schodek = Structures, Schodek

SSM = Static and Strength of Building Materials, Onouye

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| **Week** | | **Lecture** | **Assignments** |
| 1 | 1/8 | Lateral Forces: Wind and Earthquake  *BS,* Chapters 44, 45, 46  *Schodek,* Chapter 14  *ASCE7,* Chapters 6, 9 (Skim) | *Lab Assignment #1: Lateral Force Resisting Systems* |
| 2 | 1/15 | Lateral Force Resisting Systems: Wood Stud Walls and Structures *BS,* Chapter 47, 48 | *Homework #1 Lateral Forces* |
| 3 | 1/22 | Lateral Force Resisting Systems  *BS,* Chapters 54, 56 | *Lab Assignment #1: Testing* |
| 4 | 1/29 | Structural Steel Materials and Systems  ***gentry travel / guest lectures*** | **Quiz #1** |
| 5 | 2/5 | Structural Steel Framing Plans Design of Steel Beams | *Homework #2 Steel Beam Design + Framing Plans of Steel Buildings* |
| 6 | 2/12 | Steel Columns and Tension Members |  |
| 7 | 2/19 | Structural Steel Trusses Visual Analysis | *Homework #3 Design of Steel Columns and Trusses* |
| 8 | 2/26 | Introduction to Concrete Materials  *DCCM*, Chapters 1 to 7  Introduction to Load-Bearing Masonry Reinforced Concrete Buildings and Systems |  |
| 9 | 3/5 | Reinforced Concrete Elements and Reinforcing Patterns  *BS,* Chapters 27 & 30  *FBC,* Chapter 11  *BCI,* 2.14, 2.15, 2.24, 4.32, 4.33, 5.44,  5.45 | *HW #4: CIP and Precast Concrete Framing Systems* |
| 10 | 3/12 | Behavior of Moment Resisting Frames |  |

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| **Week** | | **Lecture** | **Assignments** |
| 11 | 3/19 | **SPRING BREAK** |  |
| 12 | 3/26 | Factored Load Design Concept Flexural Behavior of R/C Beams *Schodek,* Section 6.4 | **Quiz #2** |
| 13 | 4/2 | Pre-Stressed Concrete  *BS,* Chapter 34 | *HW #5: Flexural Capacity of R/C and Pre-Stressed Beams* |
| 14 | 4/9 | Flexural Design of R/C Frames Pre-Stressed Concrete  Shear Design of R/C Frames BS, Chapter 34  *BS,* Chapter 31 |  |
| 15 | 4/16 | Final Jury Week  No Class Monday or Wednesday |  |
| 16 | 4/23 | Design of Concrete Columns Design of Concrete Columns *BS,* 30, 54, 58, 59 | *HW #6: Shear in R/C Beams + Design of R/C Columns* |
| 17 | 4/30 | Final Exam Review Final Exam | **Final Exam: Thursday May 3,**  **11.30 a.m. to 2.20 p.m** |