**ARCH 6015**

**Structures I Fall 2018**

Instructor: James Case and Chris Putman

Office: After class as needed.

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Class Schedule: M W F 8:00 a.m to 8:50 a.m. Office: M F 9:00 a.m to 9:30 a.m. Building 50 (College of Computing), 801 Atlantic Dr – Room 101 or by appointment

# Course Description

This course provides students with a basic knowledge of analysis and design of building structures and the ordering of structural systems to resist gravity and lateral loads. Students will investigate the behavior of structures through design examples, case studies, and physical testing of models.

Students will gain an understanding of structural design in collaboration with their structural engineering partners.

This course and its follow-on course 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 Accreditation1.* 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.

*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.

1 https://[www.naab.org/wp-content/uploads/01\_Final-Approved-2014-NAAB-Conditions-for-Accreditation.pdf](http://www.naab.org/wp-content/uploads/01_Final-Approved-2014-NAAB-Conditions-for-Accreditation.pdf)

# Learning Objectives

Upon successful completion of this course, students will be able to:

* To calculate the mathematics and physics that govern the structural analysis and design process: external and internal equilibrium, stability, free body diagrams, internal force diagrams.
* To apply the concept of stress and strain – the mapping functions between material properties and structural requirements for load and deformation capacity.
* To describe and demonstrate the structural design process through a group collaboration project: geometric synthesis → structural idealization → load identification → structural analysis → structural design → construction;
* To evaluate and create typical structural framing schema in wood structures;
* To design wood members, both common and engineered, using allowable stress design for tension, compression, flexural, and lateral load resisting elements.

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

*Reference Texts:*

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

Form and Forces: Designing Efficient, Expressive Structures, 1st Edition (2009), by Allen and Zalewski

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.

Wood Construction Connectors, Simpson Strong-Tie Company.

# Homework

Homework will be graded and solutions will be posted on Canvas. Each homework will be assigned a due date. Homework may be completed with one partner (two people total per assignment) and must be turned in on time to receive full credit. Late homework submissions will not be received. The lowest two homework grades will be dropped. You and your partner’s names are required to be on each submission. Homework must be neat and well laid out with an easy to follow logic. Use a straight edge, underline intermediate answers, and box your final answers. Homework grades will be based on accuracy, 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 Canvas.

# Group Collaboration Project

The group collaboration project will be completed in groups of three to five students. The project will involve the inception, design, analysis, and load testing of a structure. Last year’s project consisted of a balsa wood bridge. Groups will present their concepts to a panel during a mid-review and summarize their process and results in a project paper. More information to come.

# Grading

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

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| --- | --- |
| **Assignment**  Homework (Lowest dropped) | **Percentage**  25% |
| Attendance/Participation | 10% |
| Group Project | 15% |
| Hourly Quizzes (2) | 30% |
| Final Exam | 20% |
| **Total** | **100%** |
| **Grades Are Earned As Follows:** | **Percentage** |
| A | 90-100% |
| B | 80-89% |
| C | 70-79% |
| D | 60-69% |
| F | < 60% |

# 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.

# Honor Policy and Academic Conduct

It is expected all homework assignments will be completed by the student and their partner. 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://osi.gatech.edu/content/honor-code.](http://osi.gatech.edu/content/honor-code)

# Preliminary Schedule

We will follow the preliminary schedule presented below.

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| 3 | 9/3 | **GT Holiday – 9/3 (Labor Day)** HW #2: Joint Equilibrium and | |
|  |  | Mathematics of Structural Analysis, Section Section Properties | |
|  |  | Properties | |
| 4 9/10 Mechanical Properties of Materials: Forces and | | | |
|  |  | Couples, Normal Stress-Strain, Temperature | HW #3: Mechanics of Materials |
|  |  | Effects. Bending and Shear Stress-Strain |  |
| 5 | 9/17 | Statics: Support Conditions, External Equilibrium, | HW #4: Statics and Shear and |
|  |  | Free-Body Diagrams, Determinacy. | Bending Moment Diagrams |
|  |  | Shear and Bending Moment Diagrams |  |
| 6 | 9/24 | Deflection of Beams, Form Finding of Structures |  |
|  |  | Truss Analysis: Method of Joints |  |
| 7 | 10/1 | **Quiz 1 – 10/1** HW #5: Beam Deflections and | |
|  |  | Truss Analysis: Sections |  |
| 8 | 10/8 | **GT Holiday – 10/8 (Fall Recess)** |  |
|  |  | Graphic Statics Technique for Design |  |
| 9 | 10/15 | Graphic Statics Technique for Design (cont’d) | **Group Project Assigned** |
|  |  | **Group Project Introduction – 10/15** | HW #6: Graphic Statics |
|  |  | Architecture of Wood and Wood Typologies |  |
|  |  | Introduction to NDS, Wood Adjustment Factors |  |
| 10 10/22 Tension Members in Wood. | | | HW #7: Tension and Compression |
|  |  | Column Behavior: Stability and Buckling members | |
|  |  | Compression Members in Wood | |
|  |  | **Withdrawal Deadline – 10/27** | |
| 11 | 10/29 | Beam Design in Wood HW #8: Wood beam design and | |
|  |  | Schematic Framing Plans in Wood. Use of Span framing plans in wood | |
|  |  | Tables. | |
|  |  | **Group Project Concept Presentation – 11/2** | |
| 12 | 11/5 | Schematic Framing Plans (cont’d) | |
|  |  | Framing Details (rafters, headers, bearing walls, | |
|  |  | construction) and Connections in Wood\ | |
|  |  | **Quiz 2 – 11/9** | |
| 13 | 11/12 | No Classes Scheduled (Studio Float) | |

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| --- | --- | --- | --- |
| **Week** | **of:** | **Lecture Topics** | **Homework Assigned** |
| 1 | 8/20 | The Structure of Architecture, Structure in Practice and Structural Design |  |
| 2 | 8/27 | Loads: Types, Delivery and Load Path | HW #1: Loads and Load Path |

Truss Analysis

14 11/19 Lateral Design in Wood: Diaphragms, Shearwalls.

**GT Holiday – 11/21, 11/23 (Thanksgiving)**

15 11/26

|  |  |  |
| --- | --- | --- |
| 16 | 12/3 | Plans, Details) Construction Site Visit  Collaborative Design and Final Review |
|  |  | **No class – 12/7** |
| 17 | 12/13 | **Final Exam 8:00am – 10:50am** |

**Group Project Testing – 11/26**

Structural Documentation (Foundations, Framing

Group Project Report Due (12/3)