CE311 Fundamentals of Structural Engineering (AKA Structural Analysis and Steel Design)

SYLLABUS
FALL 2016

The Course Overall

Prerequisite: ES230 Strength of Materials – IF YOU HAVE NOT PASSED STRENGTH OF MATERIALS, YOU CANNOT TAKE THIS CLASS.

Time & Place: Lecture MWF 11 to 11:50, 327 AEC
Lab (section 1): Tue. 8-10:50am, 111/* AEC
Lab (section 2): Tue 1:10-4:00pm, 111/* AEC
Lab (section 3): Thur. 8-10:50am, 111/* AEC

* Labs are generally held in Room 111 (The Structures Lab), while the adjacent rooms are used. Occasionally, computer labs (e.g., Room 302) will be used and you will be notified in advance if this is the case. This information will also be posted on the website. Class will also be held on Saturday, December 10th for the 14th Annual CE311 Steel Bridge Competition

Professor: Steve Kurtz, Ph.D., PE
Office: 118 AEC
email: kurtzS@Lafayette.edu
Office Phone: 330-5440
Cell Phone: 484-505-8673
Text-messaging is an excellent way to receive quick responses but cell reception is spotty in the AEC basement, so it’s best to come to Prof. Kurtz’s office with questions during regular hours.

Course Website: Following links from http://sites.lafayette.edu/kurtzs/ This site is updated daily. Homework solutions are posted here.

Office Hours: Monday 12 to 1 and 3 to 4
Tuesday 11 to 12
Wednesday 12 to 1 and 3 to 4
Thursday 11 to 12
Friday 12 to 1

You are required to check your Lafayette email each day to receive announcements, etc.

Required Books
- Manual of Steel Construction, 14th Edition by AISC. This text is acquired directly from the publisher at a large academic discount. See previous email from Prof. Kurtz.

Additional Reading
Additional reading will be provided on the website.
GRADE WEIGHTS

Hour Exam 1:  7%
Hour Exam 2:  7%
Hour Exam 3:  7%
Hour Exam 4:  7%
Hour Exam 5:  7%
Hour Exam 6:  7%
Class Participation:  7%
Lab Performance:  7%
Daily Homework:  15%
Comprehensive Final Exam:  29%

NUMERICAL TO LETTER GRADE CONVERSION: the student’s final weighted will be converted to the letter grade by strict application of the following:

A 92.00 to 100
A- 89.50 to 91.99
B+ 87.00 to 89.49
B 82.00 to 86.99
B- 79.50 to 81.99
C+ 77.00 to 79.49
C 72.00 to 76.99
C- 69.50 to 71.99
D+ 67.00 to 69.49
D 63.00 to 66.99
D- 60.00 to 62.99
F 0 to 59.99

COURSE OUTCOMES:
The mission of CE311 is: To enable students to design simple steel structures from: conceptual design - to analysis and member selection - to detailing and fabrication, while also preparing students for subsequent courses in the theory indeterminate structures and advanced steel design. Through this course, students will be able to:

1. Select structural steel members according to AISC standards: tension, bending, compression, and combined-force members.
2. Design welded and bolted structural steel connections: simple framing, tension connections, base plates, while distinguishing between simple and moment-resisting connections.
3. Analyze determinate beam, frame, truss, cable, and arch structures: determine reactions, axial, shear, and moment functions and diagrams; assess instability and degree of indeterminacy of structures; analyze determinate structures for moving loads using influence lines.
4. Analyze indeterminate frames and trusses by approximate methods: estimate internal shears and moments by drawing the deformed shapes of structures; apply approximate expressions and state their limitations.
5. Trace the gravity and lateral load paths of determinate structures and compute the effects on members.
6. Compute beam, truss, and frame deflections and slopes using the principal of virtual work.
7. Design, detail, and fabricate an economical model steel structure, considering structural efficiency and constructability.
8. Demonstrate rudimentary analysis and design ability with reinforced concrete flexural members.
9. Develop a three-dimensional finite element model (FEM) using SAP2000 for line (frame/beam) elements: develop correct geometry, apply loads, load combinations, output force, moment, and deflection.

WORKLOAD

Time Commitment
Students should expect to devote between 8 and 12 hours each week to the course, itself, principally solving the daily homework problems. Students should expect to devote an additional 4 to 5 hours each week to the lab portion of the course, including design work.

50-MINUTE EXAMS (7% of the grade, each)
This course will have six (6) 50-minute in-class exams. These exams will be given on alternating Wednesdays, beginning with Week 3. Hence, exams will be given on the Wednesday of the 3rd, 5th, 7th, 9th, 11th, and 13th weeks. The scope of
each exam will be limited to the material since the previous exam and will typically cover five lessons worth of material. Students will be permitted to use the AISC Manual of Steel Construction and a calculator, only.

The concept of frequent, short exams is 1) to reduce the stress of exam-taking by reducing the weight that is associated with each exam; 2) to provide more regular assessment of student knowledge so that students have a better idea of where they stand in the course; 3) to eliminate time-consuming evening exams; 4) to instill the discipline that is associated with regularity, as exams will be given on alternating Wednesdays throughout the semester. From this, it is anticipated that students will not be able to fall behind in the course.

Each 50-minute exam will consist of both computational and non-computational parts. The computational parts will consist of engineering analysis and design problems that demand substantial work. The non-computational parts will consist of conceptual questions, in the form of true/false, multiple choice, and short answer questions.

**CLASS PARTICIPATION (7% of the grade)**

Lafayette College is a liberal arts institution. One of the hallmarks of a true, classical liberal education is the ability to defend an argument, orally. In an engineering class, this translates to the ability to state, in words, whether a process is logical or illogical, whether a method is right or it is wrong. While the professor understands that some students are shy (and takes this into consideration, to an extent), students must understand that the ability to speak intelligently and publically is a vital part of his or her education. Furthermore, the contributions of any student are considered to be, not a selfish act benefiting the individual, but a service to the entire class; one may ask a question for selfish reasons, but inevitably, the answered question benefits everyone and is a service to everyone.

**Expect to be called upon.** Prepare to be called upon. Students are not expected to have the right answer every time, but students are expected to give the best answer he or she possibly can.

The professor takes notes regularly on the participation of students and assigns the grade, accordingly. A “B” grade generally requires volunteering, while an “A” grade generally requires frequent volunteering.

**LAB PERFORMANCE (7% of the grade)**

The CE311 lab is unlike any lab you have ever had. You will learn to weld and fabricate steel. You will learn new software and immediately apply it to important decision-making. You will learn material that is not otherwise taught in the classroom; think of the structures lab as a classroom that also contains welding machines. Your lab section will work as a team to design and fabricate a large steel bridge that can support 2500-lbs of load. You will perform homework assignments that help build your engineering design skills, while helping your team to win the competition.

The individual’s performance grade will be based on the following:

- Lab homework assignments, handed in the following week.
- Short quizzes on the rules of the competition or topics covered in lab.
- Your involvement in group discussions. During group discussions, Prof. Kurtz will note which individuals are making valuable contributions.
- Your contribution to analytical work: computer models, calculations, connection ideas, drawings.
- Your team’s performance in the final project; in the end, your team will be rewarded if the bridge project wins the competition. All members of the winning team will receive a bonus of 1% on his or her final grade in the course, while members of the second place team will receive a bonus of 0.5% and the members of the third place team will receive a bonus of 0.25%.

**EVENING EXAM Q & A SESSIONS AND STUDY GUIDES**

Several days prior to each exam, a Study Guide will be posted on the course website. On the evening prior to each exam, an informal question and answer session will be held, typically at 8 or 9pm.

**FINAL EXAM (29% of the grade)**

The final exam will be comprehensive. It will have a three-hour time limit. Students will be permitted to use the AISC Manual of Steel Construction and a calculator, only.

**DAILY HOMEWORK (15% of the grade)**

The purpose of daily homework is to prepare students for frequent exams. The frequency of exams and homework will do much to keep students current and eliminate procrastination.

**Basic Characteristics of Daily Homework:**

- Assigned every lesson and for many labs.
- Due by 5pm on the day of the next class (or next lab, in the case of lab assignments). Homeworks submitted outside of class must be brought to Prof. Kurtz’s office – Room 118.
Graded out of a possible 10 points. Presentation generally counts (see below). Occasionally, a few homework assignments may be returned to students without a grade. These assignments will simply be marked with a √, indicating that it was received. In the gradebook, the grade recorded for these assignments will be equal to 1 point above the student’s average on all other homeworks, on a 100-point scale. Example: if a student’s homework average is otherwise 93.2, then the √’d assignments would receive a grade of 94.2.

- Bonus point (up to 1 point) for exceptional presentation.
- Bonus point (1 point) to the student whose homework is posted as the official solution. This is a flawless assignment that communicates to other students well (simple, yet explicit) and is very well presented.
- Late homework receives a 2 point deduction if the solution has not been posted yet (see http://sites.lafayette.edu/kurtzs/). If the solution has been posted: credit for presentation, only.

When does presentation count?

- Unless otherwise noted, presentation counts. These are expected to meet professional standards of engineering communication (see Homework Standards for Engineering Classes). Typically, 2 points out of 10 are attributed to presentation.
- Some assignments or parts of assignments will clearly say “Presentation Does Not Count. Simply Hand in this Sheet”. These assignments (or parts of assignments) will be multiple choice or short answer questions, etc. that obviously don’t require the presentation of full calculations.

HOMEWORK PRESENTATION STANDARDS

This is a professional program. Students of a professional program must learn to produce professional quality technical communication. Hence, presentation is considered in most homework assignments. Typically, out of ten points assigned to each homework, eight points are for technical content, while the remaining two points are for presentation. This includes:

- Must be done on Lafayette Engineering Paper
- Must be stapled.
- Sharp sketches, dimensioned and labeled
- Accurate, brief problem statement (do not copy the professor’s words from the assignment; at least paraphrase them).
- Explicit computations (stating assumptions and logic, while justifying the procedure)
- Penmanship
- Correct units and equations, including appropriate subscripts, where needed.
- Boxed or ballooned major steps, final answers, or important conclusions
- Spelling and grammar
- Label each page: Your name, course name, date, lesson number, page numbering

ATTENDANCE POLICY

There is no specific penalty for missing a class. However, it is obvious that one cannot be a strong participant if chronically absent. Furthermore, the testimonies of many past students in this class strongly suggest that missing class costs students far more time than it saves. Hence, it is likely that poor class attendance will result in poor performance, but that decision and its associated risks rest with student.

OTHER LAB EXPECTATIONS

The lab portion of this course is a highly-physical classroom. Whereas the traditional lab paradigm views the lab experience as something that enhances classroom learning, this course uses the lab to teach subjects, outright. Though most of the lab topics have been traditionally taught in classrooms, they’ve been moved to the lab because they are subjects that particularly benefit from hands-on experience (example: the failure of bolted connections, a traditional classroom subject, is greatly enhanced by the physical process of building and testing bolted connections).

Each week, students can expect the lab to contain:

1. Design Work. The four lab sections will devote time each week to making progress with their bridge design.
2. Experimentation and/or Shop Work. Students will conduct physical tests of beams, columns, trusses, and connections, as well as learn to weld, drill, cut, and punch steel. While some of this work will be prescribed by Prof. Kurtz, students will often need to dream up their own testing program to aid their design exploration.
3. A Lesson. Expect to take notes, solve problems, and answer questions to reinforce what has been learned.
4. Calculations, Problem-Solving.

This lab will be a very active place. Unless otherwise noted, be sure to always:

- Bring a calculator, engineering paper, pencil, straight edge and be prepared to learn and take notes.
• Wear closed shoes (preferably leather) and long pants (we will often be welding and fabricating steel. No one wants molten slag in his or her shoes. It hurts.). Our “highly-physical classroom” can turn into a steel-fab shop at a moment’s notice. **Be prepared to get filthy** (steel is dirty).
• Bring a steel manual.
• Wear a short-sleeved shirt. Do not wear any loose jewelry. Loose sleeves or jewelry are dangerous and incompatible with rotating machinery.

**LAB SAFETY RULES**
Accompanying this Syllabus, students will find the Lafayette’s Structural Engineering Laboratory (LSEL) General Safety Rules. Prior to using the lab, students must have read the manual and signed the Compliance Form.

**Basic Rules — ALWAYS!**
1. SAFETY GLASSES at all times (even when no shop work is being done).
2. HAIR must be tied into a tight bun if the hair is long.
3. SHORTSLEEVE shirts, LONG PANTS, heavy-duty Construction BOOTS.
4. No baggy clothing.
5. No dangling jewelry (e.g., hoop earrings, exposed necklaces).
6. No student may work under the influence of DRUGS or ALCOHOL.
7. Students are not allowed to work alone.
8. All equipment requires specific training from Prof. Kurtz or an Engineering Technician.

**THE STEEL BRIDGE COMPETITION**
The term project is the Steel Bridge Competition. This is a competition between the three lab sections to design, detail, and fabricate the most economical 19.5’-span steel bridge according to a strict set of rules. In many ways, this competition begins on the first day of class and ends on the last day (the day of the competition, itself), as many classes and most labs focus on it, in some way. This competition will tie together virtually every lesson in the course.

**ACADEMIC HONESTY**
Any incidents of academic dishonesty will be forwarded to the Dean’s Office in strict adherence with college policies.

**Academic Honesty and Homeworks.** It is common for engineering students to work together on homework assignments and this is not considered to be a violation of Academic Honesty **IF** the work submitted by the student reflects his or her knowledge. This means that the student must have been full contributor to the thought process that lead to the problem’s solution. In contrast, students who merely follow along with the work of others are violating the rules of Academic Honesty. If there is evidence that this is occurring, Prof. Kurtz will assign zero credit for the assignment and issue a warning to the student. For example, if a student is unable to explain submitted work, this will be regarded as Academic Dishonesty.

**LESSON OBJECTIVES AND EXAMS**
For each lesson in this course (including labs), students will receive a Lesson Sheet that lists the Lesson Objectives. Lesson Objectives are not “what the professor is doing today”. Lesson Objectives are “an ability that each student is expected to demonstrate on an exam (or similar assessment method), as a consequence of the day’s lesson and associated assignment”.

Examples:
- **Draw** the moment diagram for a rigidly-connected 2D frame, subjected to wind loading, using the Portal Method of approximate analysis.
- **Calculate** the nominal moment capacity $M_n$ of a laterally-supported rolled steel section.
- **Derive** the Euler buckling equation for a pin-ended column.

There is no “background information” in this course nor will the professor devote time to topics that will not appear on the exam. Pragmatically, the professor believes that students study the material that they expect to be examined on – no more and no less. Consequently, time that is devoted to unexaminable material is more simply known as wasted time. Consistent with this, an Exam Study Guide will be posted on the website at least one week before each exam. The guide will list every objective on the exam, giving example questions and problems associated with each objective.

**EMAIL**
Students are expected to check email daily for announcements and clarifications to homework assignments.
### COURSE SCHEDULE
(see course webpage for daily-updated information, homework solutions, video files, etc.)

Whereas the individual lesson dates are likely to have small changes, the Exam Dates are unlikely to change.

<table>
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<th>Day</th>
<th>Date</th>
<th>Lesson #</th>
<th>Lesson Title</th>
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<td>Structural Engineering – Brief Intro</td>
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<td>Wed</td>
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<td>SOM Review: Direct (uniform) stress, bending stress</td>
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<td>SOM Review: V, M diagrams</td>
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<td>Load Path and Tributary Area II</td>
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<td>Load Path and Load Combinations</td>
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<td><strong>Hour Exam 1 (Lessons 1 to 5)</strong></td>
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<td>9/16</td>
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<td>Compression Members II: K Values</td>
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<td>Compression Members III: Rigid Frames – Ga, Gb</td>
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<td>No Class</td>
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<td>Compression Members IV: Selection</td>
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<td>Arches</td>
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<td>Mon</td>
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<td>Fri</td>
<td>10/7</td>
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<td>Lateral Load Path</td>
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<td>Fall Break</td>
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<td>Lateral Load Path</td>
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<td><strong>Hour Exam 3 (Lessons 12 to 17)</strong></td>
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<td>Bolts, Bolting</td>
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<td>Wed</td>
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<td>Bolted Tension Member Capacity</td>
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<td>10/21</td>
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<td>Block Shear and Shear Lag</td>
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<td>Complete Tension Member Design</td>
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<td><strong>Exam 4 (Lessons 18 to 22)</strong></td>
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<td>Fri</td>
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<td>Beams I: Fully Plastic Bending</td>
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<td>Mon</td>
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<td>Beams II: Intro to LTB</td>
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<td>Wed</td>
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<td>Beams III: LTB Capacity per AISC</td>
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<td>Fri</td>
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<td>Beams IV: Local Buckling</td>
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<td>Mon</td>
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<td>Beams V: Selection and Design Aids</td>
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<td>Wed</td>
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<td>Fri</td>
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<td>Mon</td>
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<td>PM Interaction I – Big Mac &amp; Fries</td>
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<td>Thanksgiving</td>
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<td>Wed</td>
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<td>Fri</td>
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<td>Virtual Work for Beam Deflections and Indeterminate Beams</td>
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<td>Mon</td>
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<td>Wed</td>
<td>12/7</td>
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<td>Reinforced Concrete Beams and Slabs</td>
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<td>Week No.</td>
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<td>1</td>
<td>8/30 or 9/1</td>
<td>111</td>
<td>Introduction to Structural Engineering</td>
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<td>9/6 or 9/8</td>
<td>302</td>
<td>Introduction to SAP/Sculpture Assembly.</td>
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<td>3</td>
<td>9/13 or 9/15</td>
<td>111</td>
<td>Welding, Bandsawing and SAP Modeling</td>
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<td>9/20 or 9/22</td>
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<td>Steel Fabrication and SAP Modeling</td>
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<td>9/27 or 9/1</td>
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<td>Conceptual Design</td>
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<td>Preliminary Design</td>
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<td>Fabrication</td>
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<td>Fabrication</td>
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<td>14</td>
<td>12/6 or 12/8</td>
<td>111</td>
<td>Fabrication Complete by the End of Lab*</td>
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The 14th Annual CE311 Steel Bridge Competition – December 10, 2016, 10am

* No team may use electrical power following the end of its lab section, week 14.