CE 401/601 – MATRIX STRUCTURAL ANALYSIS

SPRING 2012
TTH - Lowry 217
Section #1 3:30 – 4:45 A.M.

Professor: Dr. Sez Atamturktur *(Dr. Atam)*
sez@clemson.edu – Lowry 200
Office Hours: WF 8:00 – 10:00 A.M.

1. COURSE OBJECTIVES:

My philosophy is to inspire curiosity and to convey the thought process in solving problems that form the essence of engineering.

Specific skills you will learn in this class include:

- Establish underlying assumptions in structural analyses and idealize existing structures in model form.
- Construct stiffness matrices of truss, beam, and frame elements.
- Implement direct stiffness method to find nodal displacements, support reactions and internal member forces in truss, beam, and frame elements.
- Analyze a structure with self-straining effects such as temperature effects and foundation settlement.
- Model a structure with semi-rigid, offset and inclined supports, or member end releases.
- Calculate the effects of material or geometric nonlinearity on structural behavior of simple truss, beam, and frame elements.
- Perform a structural analysis of a realistic structure that might be encountered in professional practice using large-scale commercial programs.
- Evaluate the structural response output obtained from commercially available structural analysis software packages.

Students can expect to acquire these abilities only if they honor all course policies, attend class regularly, complete all assigned work on time and in good faith, and meet all other course requirements and expectations.

2. COURSE ADMINISTRATION:

Administration: This course will be managed on ***MyCLEmson***, and is accessible to enrolled students at https://bb.clemson.edu/. Please make use of this site, and consistently check it for updates.

Prerequisites: C or better in CE 301 or Instructor Approval.

Required Text: Matrix Analysis of Structures, Second Ed., by Aslam Kassimali.

Computer Software:
Mastan2: A free online tool to be used to understand concepts and verify homework assignments. It is available on the web: http://www.mastan2.com/
MATLAB / Excel: A commercial package that may be used to solve systems of linear equations and manipulating matrices to aid homework assignments.
SAP2000: Commercial structural analysis software to be used during homework assignments and the final project assignment.

Office Hours: Students are welcomed to make use of office hours. Office hours should not be considered as condensed versions of missed lectures or as a means of verifying the homework solutions before the deadline.

3. PROFESSOR'S EXPECTATIONS:

Class Participation: Active participation is a very important part of your learning process. Active participation includes attendance, attention, preparation (reading lecture material in advance), asking questions, answering questions and participation in in-class problem-solving sessions. A student who is prepared and actively processes the class material will master CE401/601.

You will learn the material by completing assigned reading and problem sets, in addition to material presented in lectures. Examples worked in class are not sufficient for mastery of the material. You must work additional problems on your own – the professor will regularly provide additional problems during lectures. All major course announcements, including date changes, will be given in lecture sessions. Students are responsible for all information administered in lecture sessions. *Therefore, attendance to lecture sessions is mandatory.* However, if the instructor does not arrive within the first 15 minutes of the class, students may leave.

Homework: Homework will be assigned weekly on Tuesdays. Students will have one week to complete the homework. Homework will be collected only by the professor at the beginning of the Tuesday lecture class. No late assignments will be accepted. Homework may include paper and pencil as well as computer work. *All assumptions must be stated explicitly.* Homework that is not neat and legible may be rejected. Unclaimed work will be retained for 6 weeks after the start of the next semester and then discarded.

Working together on homework is encouraged. However, for your own sake, turn in homework that reflects your complete, *personal* understanding of the material. Any computer program developed for homework assignments must not be duplicates of other students programs. This standard is self-enforcing –your individual understanding will be reflected in the problems you work on the examinations.

Examinations: Exam problems will be designed to assess your fundamental understanding of the course objectives. This means the examination problems will probably **NOT** resemble problems worked in class or in homework. All quizzes, midterms and the final examination

will be *comprehensive*. The format of each midterm may vary. Unless otherwise specified, all examinations are closed book / notes.

If the student provides the professor with credible written evidence of a legitimate excuse, *there will be one comprehensive make-up exam at the end of the semester (see optional evening exam in the schedule).*

4. ACADEMIC INTEGRITY:

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.

When, in the opinion of a faculty member, there is evidence that a student has committed an act of academic dishonesty, the faculty member shall make a formal written charge of academic dishonesty, including a description of the misconduct, to the Associate Dean for Curriculum in the Office of Undergraduate Studies. At the same time, the faculty member may, but is not required to, inform each involved student privately of the nature of the alleged charge.

The Honor Code: Each student must comply with the Honor Code as approved by The College of Engineering of Clemson University.

5. COURSE GRADING:

Each student's *lowest Homework Score* will be dropped. An optional, comprehensive fourth midterm will be provided for those who (1) want to replace one of their first three midterm exams with the optional fourth and (2) have a legitimate written reason for a make-up.

CE 401		
Homework		11%
Three Midterm Exams		54%
First Midterm	15 %	
Second Midterm	17 %	
Third Midterm	22 %	
Final Examination		25%
Final Project		10%
Instructor's Bonus		±1%

CE 601		
Homework		11%
Three Midterm Exams		45%
First Midterm	12 %	
Second Midterm	14 %	
Third Midterm	19 %	
Final Examination		25%
Final Project		19%
Instructor's Bonus		±1%

This course's grades may be curved or adjusted to shift students' grades positively, but not negatively.

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Any objections to the homework, exam or project grades must be submitted in **written format** with justification supported by citations from textbooks, lectures or in-class discussions within one week after each exam.

6. TENTATIVE COURSE SCHEDULE:

Lecture Schedule

Week	Lecture	Day	Date	Topic	Text	Notes / Assignments
1	1	TH	1/12/2012	Syllabus Overview Introduction	Kassimali Chapter 1	Classes Begin
2	2	T	1/17/2012	Flexibility versus Sitffness Methods: Concept	Kassimali Chapter 1	HW1 Assigned
	3	TH	1/19/2012	Flexibility versus Sitffness Methods: Determinacy		
3	4	T	1/24/2012	Definitions and Concepts: Coordinate Systems	Kassimali Chapter 2	HW1 Due / HW 2 Assigned
	5	TH	1/26/2012	Matrix Algebra		
4	6	T	1/31/2012	Excel Tutorial		HW2 Due / HW 3 Assigned
	7	TH	2/2/2012	SAP and MASTAN tutorial		
5	8	T	2/7/2012	Axially Loaded Members: Element Stiffness	Kassimali Chapter 3	HW3 Due / HW 4 Assigned
	9	TH	2/9/2012	Axially Loaded Members: Stiffness Assembly		
6	10	T	2/14/2012	Axially Loaded Members: Direct Stiffness Method	Kassimali Chapter 3 (& 7)	HW4 Due / HW 5 Assigned
	11	TH	2/16/2012	Axially Loaded Members: Thermal Changes, Settlements and Inclined supports		
7	12	T	2/21/2012	*EXAM #1*	Kassimali Chapter 3 & 4	HW5 Due / HW6 Assigned
	13	TH	2/23/2012	Prismatic Beams:Element Stiffness		
8	14	T	2/28/2012	Prismatic Beams: Direct Stiffness Method	Kassimali Chapter 4 (& 7)	HW6 Due / HW7 Assigned
	15	TH	3/1/2012	Prismatic Beams: Thermal Changes and Settlements		
9	16	T	3/6/2012	Prismatic Beams: Intermediate Loadings	Kassimali Chapter 4 (& 7)	HW7 Due / HW8 Assigned
	17	TH	3/8/2012	Prismatic Beams: Member Release		
10	18	T	3/13/2012	Non-prismatic Beams	Kassimali Chapters 4 (& 9)	HW8 Due/ HW9 Assigned
	19	TH	3/15/2012	*EXAM #2*		
11	20	T	3/20/2012	SPRING BREAK	Kassimali Chapter 13	HW9 Due / HW10 Assigned
	21	TH	3/22/2012	SPRING BREAK		
12	22	T	3/27/2012	Frames: Coordinate Transformation	Kassimali Chapter 6	HW10 Due / HW11 Assigned
	23	TH	3/29/2012	Frames: Direct Stiffness Method		
13	24	T	4/3/2012	Frames: Inclined, Offset and Semi-rigid Connections	Kassimali Chapters 6 & 10	HW10 Due / HW11 Assigned
	25	TH	4/5/2012	Nonlinear Analysis: Introduction		
14	26	T	4/10/2012	Nonlinear Analysis: Matrix Approach	Kassimali Chapter 10	HW11 Due / HW12 Assigned
	27	TH	4/12/2012	Geometric Nonlinear Analysis		
15	28	T	4/17/2012	Geometric Nonlinear Analysis	Kassimali Chapter 10	HW12 Due
	29	TH	4/19/2012	EXAM #3		
16	30	T	4/24/2012	Material Nonlinear Analysis	Notes	EVENING MAKE-UP EXAM!!!!
	31	TH	4/26/2012	Final Exam Overview		Project Reports Due!!!

The above schedule, policies and assignments in this course are subject to change in the event of extenuated circumstances.

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HINTS FOR SUCCESS IN CE 401/601:

- Do not get behind. Studying regularly and devoting the necessary time to review the class material is the key for success. Although the time required to master the material may vary depending both on the student and topic, I recommend studying 9 -12 hours a week.

- Working numerous problems is the best way to learn structural analyses and design. Show your best effort in all homework problems. However, your studies should not be limited to homework problems; you must solve additional problems on your own. Throughout the course, guidance will be given to identifying additional problems.

- There is no substitution for working together with friends. Teaching each other and asking questions are fundamental to learning. Make sure you have a study group for this class.

- Before and after a new topic is covered in class, read the material provided in the course packet. Reading in advance will help you understand the lecture better; while the later reading will help you refresh your memory and see the big picture.

- Start thinking about the Final Project immediately after reading the project description.

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FINAL PROJECT DESCRIPTION

The task is to build a numerical model of Lowry Hall in SAP2000 frame analysis software. CE 401 students are asked to build the model for one bay of Lowry Hall (further instruction will be provided regarding the precise location of the bay); and CE 601 students are asked to build the model for the entire structure (excluding the link between Lowry and Lee Halls). CE 401 Students will work in groups of two, while CE 601 students will work individually. CE 401 students will have the option to sign up in a team of their choice. Any student not signing up with a team will be assigned to one by the instructor by the ***second week*** of the semester.

The numerical model will be used to execute a static, modal and dynamic analysis. The model predictions of natural frequencies and mode shapes will be compared against real life measurements obtained on site from the Lowry Hall. Models built with appropriate stiffness and mass distribution will yield close agreement with the on-site measurements. Recognition will be given to the group/student for the model predicting the first three natural frequencies within 10% of the measured frequencies (the mode shapes should depict visual agreement).

Students will report the (1) field survey, (2) geometric model development, (3) material property definition, (4) boundary condition identification and (5) predicted response behavior of the selected structure. The report should be 5-10 pages for CE 401 student and 12-20 pages for CE 601 students. The report should be single-spaced text with graphs, pictures, figures, calculations, etc. The report should first introduce the structure chosen and explain the load path through which the structure carries load to its supports. The report should also describe the process used to determine the member sizes and connection details.

Modeling Criteria:

- All structural members must be included in the model.
- When geometric simplifications are necessary, the properties of structural members (cross sectional area, moment of inertia…etc.) must be preserved.
- All non-structural members must be included as self-weight.
- Material properties must be determined from published literature.
- Boundary and support conditions must be determined with *best-engineering-judgment*.

Analysis Criteria:

- **Static Analysis under Dead Load and Live Load:** determine the shear and moment distribution for all structural members under dead load and live load (apply appropriate factor of safety).
- **Modal Analysis:** predict the first three natural frequencies and mode shapes to determine the model accuracy.
- **Dynamic Analysis:** To be determined by the instructor.

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Grading Rubric:

Criteria	Marginal	Proficient	Exemplary
Model Accuracy ***30%***	30% or more error *15%*	Between 10-30% error *20%*	10% or less error *30%*
Report ***30%***	Assignment instructions not followed. Writing plagiarized from other sources. Incomplete, incorrect or incoherent technical information. *0-10%*	Assignment instructions Followed. The report is original work. Complete, correct and coherent technical information. *35%*	An evident effort beyond a 'proficient report.' The report includes reference material as well as proper citations. *40%*
Results ***30%***	An informal presentation and poor use of allocated space. *0-10%*	A formal, well organized, coherent presentation with correct information. *25%*	Analysis and synthesis of information beyond 'proficient' level. *30%*
Individual or Team- Work ***10%***	Delayed assignment submissions. *0%*	An evidence of productive team work. *10%*	An evidence of productive and punctual team work. *10%*