THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Aerospace Engineering and Engineering Mechanics

COE 321K Computational Methods for Structural Analysis
Spring 2021

SYLLABUS

Unique Number: 13960

Instructor: Prof. Chad M. Landis
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Office hours: MWF 2:00-3:00 pm

Time: MWF 1:00-2:00 pm, M 4:30-6:30 pm

Location: Online

Teaching Assistants: Amin Anvari, anvari@utexas.edu, OH TBA
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Web Page: Available on Canvas

Catalog Description:
Analysis of aerospace structural systems, with emphasis on matrix methods.

Course Objectives:
To be able to analyze aerospace structures using the concepts of equilibrium, kinematics, and material constitutive behavior. Emphasis is placed on systematic approaches compatible with the use of matrix solution methods.

Prerequisites:
EM 319 and ASE 211 with a grade of C- or better in each.

Knowledge, Skills, and Abilities Students Should Have Before Entering This Course:
Basic geometry, trigonometry, calculus, matrix analysis, and knowledge of engineering mechanics.

Knowledge, Skills, and Abilities Students Gain from this Course (Learning Outcomes):
Basic principles of equilibrium, geometric compatibility, and material constitutive behavior as applied to the systematic analysis of engineering structures.

Impact On Subsequent Courses In Curriculum:
The topics of this course must be understood by anyone concerned with structures and materials and are essential for the design of aerospace structures that are both functional and safe.

Relationship of Course to Program Outcomes:
This course contributes to the ABET Criterion 3 student outcomes that took effect with the Fall 2019 semester. For more information, see *Criteria for Accrediting Engineering Programs, 2019 – 2020* at https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/

STUDENT OUTCOME	
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	√
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. an ability to communicate effectively with a range of audiences	
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

ABET Program Criteria Achieved:
Program criteria are unique to each degree program and are to be compiled from the program criteria given for each degree program and listed in table format below. The faculty should check which of the program criteria are achieved in the course.

Criterion		Criterion		Criterion	
A. Aerodynamics		G. Orbital Mechanics		M. Preliminary/Conceptual Design	
B. Aerospace Materials		H. Space Environment		N. Other Design Content	
C. Structures	√	I. Attitude Determination and Control		O. Professionalism	
D. Propulsion		J. Telecommunications		P. Computer Usage	√
E. Flight Mechanics		K. Space Structures	√		
F. Stability and Control		L. Rocket Propulsion			

Topics:
Methods for the numerical analysis of structures including trusses, frames, and continuous systems.

Professionalism Topics:
During lectures, the instructor stresses the importance of discipline, ethics and organization in the success of engineering students in their careers.

Design Assignments:
Students will be required to interpret numerical results within the context of design decisions.

Laboratory Assignments:
There are no laboratory assignments for this course.

Computer:
Students will be required to write programs in either a basic programming language, e.g. Python, Fortran, or C, or in a math package, e.g. Matlab.

Optional Recommended Texts:
J.M. Gere, *Mechanics of Materials*, Brooks/Cole, 6th Edition, 2004.
R.L. Sack, *Matrix Structural Analysis*, Waveland Press, 1994.

Class Format:
Each week there will be three lectures (3 hours total) and one discussion session (2 hours). The lectures formally present the topics covered in this course, and the discussions emphasize on problem-solving procedures.

Class Outline and Schedule (tentative):

Week 1 Introduction, Review of basic concepts, *Gere* Chs. 1&2
Statically indeterminate trusses, *Sack* Ch. 2
Week 2 Element stiffness methods, *Sack* Ch. 2
Assembly of element stiffness to global stiffness, *Sack* Ch. 2
Week 3 Computational procedures for trusses, Local stiffness matrices, *Sack* Ch. 3.3
Rotation of local stiffness to global coordinates, *Sack* Ch. 3.3
Week 4 Three-dimensional truss elements, *Sack* Ch. 5
Beams and frames, *Sack* Ch. 4
Week 5 Beam element stiffness, Beam element shape functions, *Sack* Ch. 4
Consistent nodal loads, *Sack* Ch. 4.3
Week 6 Buckling, *Gere* Ch. 11, Frames, *Sack* Ch. 4
Minimum potential energy
Week 7 Energy methods for frame elements
Three-dimensional frame elements
Week 8 Example problems
Review
Spring Break
Week 9 Continuous systems
Principal of virtual work
Week 10 PVW for bar elements
PVW for beam elements
Week 11 FE methods for beams based on PVW
Analysis of strain and rotation, Equilibrium equations for stresses
Week 12 Structural analysis of general solids
FE methods for general solids based on PVW
Week 13 FE methods for two-dimensional solids

	Triangular elements
Week 14	Example: continuous bar
	Example: beam on elastic foundation
Week 15	Stress concentrations
	Review
May 13	**Final 9:00 am – 12:00 pm**

Grading:
Homework (35% total)
2 Midterm exams (15% and 25% for low and high score)
1 Final Exam (25%)

Homework Policy:
- Homework problems will be assigned in class and during the recitation/lab.
- Acceptable homework format is detailed on the course webpage.
- Late assignments will not be accepted.
- Homework will count for 35% of the final grade.

Examinations:
- There will be two midterm exams.
- The dates of the exams will be announced at a later time.
- The two midterm exams will count as 15% (low score) and 25% (high score) towards the final grade.
- A final exam will be given during the officially scheduled time. This schedule is set by the Registrar.
- The final exam is comprehensive.
- The final exam will count as 25% towards the final grade.

Attendance:
Regular attendance is expected.

Important Dates:
02/03 – Last day to drop a course for a possible refund
04/05 – Last day to drop a course with dean's approval
05/13 – Final Exam, Thursday May 13, 9:00 am – 12:00 pm

Special Notes:
The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

Evaluation:
Note that the Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor.

Sharing of Course Materials is Prohibited: No materials used in this class, including, but not limited to, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized

sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course. Due to the use of Chegg and other online "help" sites to cheat, the use of any and all such sites is prohibited in this class, as is the use of any non-UT affiliated "tutor".

Class Recordings: Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Prepared by: Chad M. Landis Date: 01/13/2021