

MAE 456 – CAD/Finite Element Analysis

- Instructor:** Terence Musho, PhD, PE
Office: 727 ESB
Phone: (304) 293-3256
Terence.Musho@mail.wvu.edu or tdmusho@mail.wvu.edu or
tdmusho@mix.wvu.edu (all forward to same email)
Office Hours: T 1:00 PM – 1:50 PM
or by appointment on Zoom
TA Office Hours: TBD
- Lecture:** MW 1:00 – 1:50 PM Room MRB 113(Lecture)
Lab: M 2:00 – 3:50 PM Room ESB-E G78B (Lab Section 2)
T 2:00 – 3:50 PM Room ESB-E G78B (Lab Section 3)
- Text:** None
- Reference:** Introduction to Finite Element Analysis and Design, N. Kim and B. Sankar, Wiley, 2009
- Pre-requisites:** MAE342 (or MAE245) and MAE 343
- Required Course Supplies:** >8Gb USB drive, Laptop/Desktop with Web camera, Camera/Scanner for generating PDFs, PC that can run Required Software.
- Required Software:** [Matlab](#), [ANSYS Student](#), [Solidworks](#) (Download and Install)
Students need to download and install on personal machines or use computers on campus. 2nd Floor ESB computer lab or ESB756 MAE computer lab. ESB756 is available to use unless there is lab scheduled in classroom.
- Course Objectives:** The objective of this course is to provide students with the necessary knowledge of computer-aided design (CAD) and finite element analysis (FEA). The course will provide students with the methods needed to formulate analytical and numerical solutions to engineering problems. Applications will be presented and discussed. Goals¹ of this undergraduate CAD/FEA course are for the students:
1. To introduce the fundamental concepts of the finite element method as a tool for the simulation mechanical systems response to prescribed loading conditions
 2. To develop students' skills that are necessary to model, design, and analyze engineering mechanical and structural systems of practical significance using commercial FEM software.
 3. To predict, anticipate, and avoid failure of mechanical or structural systems through an understanding of professional, legal, and public welfare consequences caused by those failures.

Course Learning Outcomes: This course supports the following ABET Learning Outcomes:

	Description	ABET Outcomes
1.	The capability of using the variational formulation to derive the stiffness matrices of basic finite elements for the static analysis of elastic structures is used in engineering applications.	1
2.	The capability of using FEA to design and analyze mechanical or aerospace components and systems with an emphasis on safety, failure prevention, and performance effectiveness. With an understanding of professional, legal, and public welfare implications of potential failures of mechanical or structural systems.	2
3.	The capability of organizing and conducting teamwork to integrate individual components into a system and to meet specific performance requirements under realistic functional constraints to drive decision-making regarding system design.	5
4.	The capability of writing comprehensive technical reports to document design, analyses with conclusions, recommendations (and implications of not observing the recommendations) for a component or system, considering appropriate engineering standards.	3

Grading Lecture: Mid Term Exam.....50%
Final Exam50%

Grading Lab: Lab Assignments.....80%
Design Project.....20%

A final letter grade will be assigned on the following basis:

90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
Below 59	F

Class Rules:

1. A professional attitude in class is expected from all students.
2. No use of cell phones is allowed during exams.
3. Attendance is mandatory. Attendance points may be given as an additional lab assignment grade. Class attendance will be taken with Google Spreadsheet.
4. Lab assignments will be submitted on e-campus on or before the due date. You will have unlimited submission attempts up to the deadline. Preview submitted PDF for corruption after uploading. PDF format is required. Note: maximum upload size is 15Mb on e-campus. You need to make sure file is not corrupt by previewing file after submitting. Corrupt files are consider a non-submission.
5. All assignments must follow the template provided.

6. Make-up exams will be strongly discouraged and will only be allowed in the event of an excused absence or illness. In these instances, the make-up will be given at the instructor's convenience.
7. Completeness, neatness, and legibility in assignments, exams, and projects are mandatory. If I cannot read your writing, you will get zero.
8. All assignments will be submitted on ecampus. No assignments will be accepted over email.
9. **NO LATE LAB ASSIGNMENTS WILL BE ACCEPTED.** Ecampus submission links will close promptly at due dates and times. If you are part of a student project on a field trip or become ill, you must notify before due date to submit late lab assignment.
10. If you submit late lab reports because of excused absence, they may not be graded until the end of the semester.
11. Hats must be removed during exams. Book bags need to be zipped and placed under chairs.
12. If we have a Guest Lecture attendance will be worth one lab assignment grade.
13. Each student is required to have a >8Gb thumb drive to backup simulation files created during lab exercises. It is necessary to run simulations on local machine's hard drive and copy files over to thumb drive at end of class. Best practice is to archive Ansys file (File->Archive) and select option to save without results.
14. ANSYS files may be required to be submitted with assignment and exam answers. Missing ANSYS result files may result in zero for assignment or exam.
15. Lab reports and Ansys log files submitted on ecampus will be scanned for uniqueness. Students submitting similar files will be reported to the Office of Academic Integrity.

Academic Integrity: The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the WVU Academic Standards Policy (<http://catalog.wvu.edu/undergraduate/coursecredittermsclassification/>). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter. In addition, The Statler Policy of Academic Integrity will be used to address instances of academic dishonesty according to the following table:

STATLER POLICY OF ACADEMIC INTEGRITY

(Approved by the Statler College Academic Standards Committee, 28 March 2019)

Case	Violation	Penalty
1	Cheating or plagiarism on minor course element (e.g. quiz, weekly lab report, homework as specified in the syllabus).	Report of academic dishonesty. Grade of zero on the entire minor course element. Possible one-letter reduction in final grade.
2	Cheating or plagiarism on a major course element (e.g. exam, project).	Report of academic dishonesty. Grade of zero on the entire major course element. Possible additional one-letter reduction in final grade. Possible UF † recommendation. Possible exclusion from further participation in class.
3	Collusion on major course element.	Report of academic dishonesty. Exclusion from further participation in class. Failure of the course. Recommendation for UF †.
4	Other (document alteration, tampering with records, etc.).	Report of academic dishonesty. Grade of zero on the entire major course element. Possible additional one-letter reduction in final grade. Possible failure in the course. Possible exclusion from further participation in the class. Possible UF † recommendation.

* Dismissal from the Statler College is permanent for Academic Integrity violations. Student conduct violations can be considered dismissal.

† UF– Unforgivable F Grade, cannot be replace under D-F repeat policy.

π Separable sanctions (e.g. dismissal from Statler College, suspension, or expulsion from WVU) will be recommended for aggravated or second Academic Integrity offenses.

§ Warning letters may be issued from the Statler College or the WVU Office of Student Conduct.

Sanctions will be assessed at the instructor and at the college/university levels. Additional sanctions may be assigned at the level of the instructor, college, and/or university.

Statler Policy on Smart Devices: The use of programmable calculators or smart devices (including smart-phones, smart watches, tablets, cameras, wearable devices, etc.) is prohibited unless specifically indicated by the instructor.

Inclusive Statement: The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Accessibility Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives.

Adverse Weather Statement: In the event of inclement or threatening weather, everyone should use his or her best judgment regarding travel to and from campus. Safety should be the main concern. If you cannot get to class because of adverse

weather conditions, you should contact your instructor as soon as possible. Similarly, if I am unable to reach the class location, I will notify you of any cancellation or change as soon as possible, using email to prevent students from embarking on any unnecessary travel. If you cannot get to class because of weather conditions, instructors will make allowances relative to required attendance policies, as well as any scheduled exams, quizzes, or other assessments.

Appropriate Use of Technology: Use of technology in the classroom should always be directly related to class activities and/or course learning outcomes. Inappropriate technology use can be an impediment to learning and a distraction to all members of the class. As such, inappropriate use of technology in the classroom may be considered a disruption of the class and constitute a violation of the WVU Student Conduct Code and could potentially result in a referral to the Office of Student Conduct. Use of technology in the classroom when specifically prohibited by the instructor may also constitute a violation of WVU's Academic Integrity policy.

Fundamentals of Engineering (FE) Exam: I strongly encourage all students to sign up and take the FE exam this semester or next. You will be excused from lab assignments (not exams) due the week before when you take FE exam. Please send me an email notifying me when you are taking the exam.

Class Schedule Fall 2023

Week 1	Lecture: Rigid Plate System	Lab: ANSYS APDL Rigid Plate and Springs
Week 2	Lecture: Uniaxial Bar Element	Lab: MATLAB Rigid Plate and Springs
Week 3	Lecture: Truss Element	Lab: ANSYS APDL Truss Element
Week 4	Lecture: 1D Beam Element	Lab: ANSYS APDL Beam Element
Week 5	Lecture: 2D Beam Element	Lab: ANSYS APDL Buckling
Week 6	Lecture: Stress and Strain	Lab: ANSYS APDL Shell Element
Week 7	Lecture: Variation Method Mid-Term Exam (9/27)	Lab: ANSYS APDL Solid Element
Week 8	Lecture: Triangular Plane Element	Mid Term Exam
Week 9	Lecture: Triangular Plane Element	Lab ANSYS Workbench Solid Element Static
Week 10	Lecture: Rectangular Plane Element	Lab: ANSYS Workbench Hyperelastic Contact Static
Week 11	Lecture: Rectangular Plane Element	Lab: ANSYS Workbench Modal/Harmonic Analysis
Week 12	Lecture: 2D Rectangular Element	Lab: ANSYS Workbench Heat Transfer
Week 13	Lecture: Iso-Parametric Mapping	Lab: ANSYS Workbench Explicit Dynamic
Week 14	Lecture: Numerical Integration	Lab: ANSYS Workbench Design Optimization Parameters
Week 15	Lecture: Zero Energy Modes	Lab: ANSYS Workbench Topological Optimization
Week 16	Lecture: Explicit Methods	Lab: ANSYS Discovery Topological Optimization
	Final Exam Section 2	TBD
	Final Exam Section 3	TBD

MAE 456 FEA Lab Report Guide

1. Introduction

The purpose of this document is to illustrate for you the basic principles of report writing for the MAE 456 course. The instructions in this handout, if properly followed, will allow you to become proficient with what can be the difficult task of writing reports. Be aware that proficiency in technical writing is a critical capability for your future professional life.

2. General Guidelines

Some labs require that the overall format of the lab report be applied to several simulations. It is important to read over this lab guide to make sure your lab report contains all specified requirements designated for the lab report.

It is important to note that when grading lab reports, length or wordiness of reports is not considered. As you are writing a technical report, it is imperative that your writing be complete, concise, and accurate, not necessarily lengthy. Each of your reports should fall somewhere between 2-7 pages, depending on the lab requirements.

Your lab reports should be written to a person who is an engineer, but who is not familiar with the particular lab you are doing. Include enough detail that the reader can visualize your setup, assess your methods and understand clearly what you discovered. The write-ups are to demonstrate that you understand the objectives, methods, and outcomes of the simulations and should be done in your own words. Do not copy and paste sections of the lab instructions into your report.

Generally, a laboratory report for MAE 456 should have the following sections. Exceptions will occur, but for most, you should use the following outline as a template for your report.

3. Sections of Report

Cover Page

The cover page should be neatly formatted and include the name, number, and date of the lab, the lab section (e.g. Tuesday, Wednesday morning/afternoon, or Thursday), lab station number, and the names of all lab partners.

Abstract

This is 150 words that highlights what you conducted and your findings. 2-3 sentences.

Introduction

This should be a short introduction to the lab or a particular simulation. It should have a concise statement of the objective of the lab assignment as well as any other pertinent information about the lab.

Procedure

This part of the report should lay out the procedure followed through the lab, in your own words. You should also include screen captures or photographs as appropriate to tell the story. It is acceptable to write this section in either bullet/list format or paragraph format, as long as it completely recalls all steps taken during the lab. All figures should have captions that are sentences.

Results and Discussion

This section should include all data collected in the lab as well as any results or findings of each simulation. This is where any questions asked during the lab or required results should be answered or explained. It is also important to state any reasons for your results not matching theoretical results or any inconsistencies with your data and possibly reasons for these inconsistencies. Illustrations or pictures taken during lab should be included here to help explain any setups created or results from experiments and may be embedded directly in the text or referenced to an Appendix. All images should

be in a text box with the caption within text box. See template for guidance on figures. Don't be afraid to use subfigures. All captions should be sentences!

Conclusion

This should be a conclusion stating the overall findings of the lab and how they relate to the lab objectives. Do not just report the values that we can all read in the Results section. The Conclusions is where you interpret the data and provide your best explanation of what it all means. This could include some observations on how the experiment could have been improved, or some suggestions for additional measurement that could be taken in a later experiment. This does not have to be a book, but it does have to represent some thought and exhibit that you understand the principle involved.

Bibliography

If references to external documents are used, they must be cited properly using "End-note" style and a bibliography must follow the Conclusions section.

Appendices

Some lab reports may include significant amounts of data that would clutter the main body of the report, or lengthy computer programs that would detract from the flow of the document. Unless the program is the main deliverable for the lab, it should be placed in an Appendix. Voluminous data should be summarized by presenting graphs or statistics and the original data should be provided in an Appendix.

In the report, pages must be numbered starting after the cover page. Figures/pictures must include captions with the number and title of the figure. Tables must also include captions with number and title. All graphs must have a title, and axes must be labeled with the variable being displayed and the units of measure. Equations must be sequentially numbered.

4. Lab Report Submission

It is important that lab reports are turned in on time. All reports must be submitted in PDF format. No *.doc or *.docx files will be accepted. Once your file is uploaded check that it displays correctly. Lab reports will be due one week after the start of the previous lab. eCampus submission boxes will close promptly at their associated due dates. Lab reports will not be accepted over email.

5. General Grading Rubric

Each lab has a total of 10 points. It will be graded by one of the Teaching Assistants (TA) following the general guideline below:

Completeness

A complete report should include at a minimum the following sections: 1. Cover page; 2. Abstract; 3. Introduction; 4. Procedure; 5. Results and Discussion; 6. Conclusion. Each missing component will cost the students 1 point. Half point will be deducted if a section is not complete.

Write-up

Up to 3 points will be deducted if the report is poorly written. If the report is mostly figures without descriptions zero points will be given.

Technical

Half point will be deducted for each major technical mistake or omission in the document.

Question

If there are questions asked in the lab guide, 0.5 point will be deducted for each question not answered or answered incorrectly.

Final Grade

The final grade should be between 0-10.