Syllabus
MAE 456 CAD/FINITE ELEMENT ANALYSIS (CRN: 82367)
Term: Fall 2018

Meeting time & Room:
- Sec 1, Lect: M, W 8:00 to 8:50 CRN 81927 Room NRCE-101
- Sec 2, Lab: M, W 9:00 to 10:50 CRN 80983 Room ESB-G78B
- Sec 5, Lab: T, Th 9:00 to 10:50 CRN 81447 Room ESB-G78B

Instructor office, phone and email:
Dr. Victor H. Mucino, Office ESB-841B
Ph. (304) 293-3150,
e-mail: vhmucino@mail.wvu

Office Hours: M 4:00 – 5:00, T & W 2:00 – 3:00 (other times by appointment).

TA & Office Hours: Manuel Serrano Laguna TBA (other times by appointment)

Textbook:
No textbook required, Recommended References:
1. ANSYS User’s Manual, on-line documentation of ANSYS.
4. Assorted handouts by V.H. Mucino, to be distributed in class.

Prerequisites:
MAE342 (or MAE345) and MAE 343 (MANDATORY)

Supplies:
Portable 8G Thumb-drive

Course Objectives
The objectives of this course are first, to introduce the fundamental concepts of the finite element method as a tool for the simulation mechanical systems’ response to prescribed loading conditions and second, to develop the skills necessary to model, design and analyze mechanical and structural systems of practical significance using commercial CAD and FEM software. A variety of operating conditions will be used, including static and thermal loading, dynamic loading, free and force vibrations, transient loading response and some non-linearities such as contact problems and plastic behavior.

Course Learning Outcomes: Students will be able to develop and demonstrate

1. The capability of formulating and use finite element stiffness matrices to determine structural response (displacements, strains and stresses) to static loading under prescribed boundary conditions for various structure types.  
   **ABET Outcomes* E

2. The capability of using commercial FEM software to model and analyze simple mechanical, structural or aerospace systems components  
   **ABET Outcomes* E, K

3. The capability of designing relatively complex mechanical systems with emphasis in failure prevention  
   **ABET Outcomes* C, E

*This course effectively supports more ABET Outcomes than those shown in this table, but will provide evidence to support the assessment of ABET outcomes C, E and K.*
HOW OUTCOMES WILL BE MEASURED:

- 5 Assignments
- 2 Tests (Fundamental knowledge)
- 2 Term-Team Projects
- Use of CAD tools in assignments and projects and exams.

FORMAT FOR THE CLASS:

The class will be divided into teams of four (4 max) students and will be given various assignments and a term project for the semester. But some assignments are individual.

Some assignments will be individual, done in paper (by hand) and submitted in class. Other assignments will be computer assignments and will be submitted electronically via Internet as will be announced.

There will be four types of sessions as follows:

A) Lecture sessions. Monday and Wednesday (first hour) to present and discuss topics of general interest.

B) Computer instruction sessions. Mondays (Tuesday) (unless otherwise announced), to demonstrate the use of the CAD software and hardware available.

C) Computer practice sessions. Wednesday (Thursday) (unless otherwise announced), to practice the use of the CAD software and hardware available.

D) Exam sessions: There will be two exams in FEM and two exams in CAD. Each exam will be strictly individual.

COURSE OUTLINE

1. INTRODUCTION

- Course description
- The Comprehensive Design Process
- The responsibility of the Professional Engineer
- General discussion of CAD Techniques
- Introduction to ANSYS
- On validation of results and liability and ethics in the use of CAD
- Assignment of Projects

2. FINITE ELEMENT FUNDAMENTALS

- Introduction to Finite Element Theory
- The stiffness matrix for truss structures
- Significance of boundary conditions
- Minimum potential energy principle
- Variational approach to finite element formulations
  - Linear Truss Elements
  - Plane Solid Element formulation (Triangular and Quadrilateral elements)
  - Linear Beam Element formulation
• Mass matrix and dynamic systems
• Linear Isoparametric elements (parabolic and cubic elements)
• Field Problems and Heat Transfer Formulation
• Weighted Residuals Formulation - Galerkin Method
  - Applications to heat transfer, irrotational fluids & elasticity problems.

3. SPECIAL APPLICATIONS OF CAD SOFTWARE (ANSYS)
• Modeling strategies for mechanical and structural systems
• Interfacing various CAD tools
• Surface modeling of complex geometries
• Solid modeling of complex geometries
• Summary of lessons learned

4. CASE STUDY No. 1. DESIGN FOR STRENGTH
• Problem definition
• Justification for CAD application
• Review of "Design" issues
• CAD modeling and analysis
• Summary of results

5. CASE STUDIES No. 2, 3, 4 DYNAMIC SYSTEMS
• Problem definition
• Review of tools required
• Justification for CAD tools
• Review of "Design" issues
• CAD modeling and analysis
  - Modal Analysis
  - Harmonic Analysis
  - Transient Analysis
  - Spectrum Response Analysis
• Summary of results

6. CASE STUDY No. 5, 6 HEAT TRANSFER & THERMOELASTIC RESPONSE
• Problem definition
• Review of tools required
• Justification for CAD tools
• Review of "Design" issues
• CAD modeling and analysis
• Summary of results

7. Final Project and Final Exam
• Discussion
• Preparation
TERM PROJECT
Students will develop a project in teams of four (4). The project will be assigned during the third week of the course and will require students to make use of the computational tools such as ANSYS, and Solid Edge to design, model, simulate and analyze a mechanical system to perform a specific function under prescribed loading conditions and constraints. A midterm report and a final report of professional quality (word processor narrative, computer sketches, engineering calculations, etc.) will be required. The final project report will be due the last day of classes.

Class Attendance Policy
Class attendance contributes significantly to academic success. Students who attend classes regularly tend to earn higher grades and have higher passing rates in courses. Excessive absences may jeopardize students’ grades or even their ability to continue in their courses. Students are responsible for missed work and for assignments given during absences.

Attendance will be randomly taken. Students with more than 10% absences will be penalized by using the attendance percentage as a final grade multiplier. For anticipated special circumstances student must seek instructor’s approval.

CLASS RULES:
1. Professional attitude in class is expected from all students.
2. No cell phones or smart devices (pads, watches etc.) allowed in class,
3. Disruptive behavior in class will not be allowed (that includes reading newspaper, falling asleep, using music players and talking).
4. Assignments must be submitted IN CLASS at the time they are due. (NOT responsible for assignments submitted in mailbox, in the halls or under my office door)
5. Late assignments will be heavily penalized 10% per day.
6. Late assignments will not be accepted after solutions are discussed in class or after one week past due.
7. All assignment problems must be presented on individual pages on plain white paper or engineering pad paper (each page must have DATE and NAME.
8. Missing an exam for an unacceptable reason* will result in a Zero grade for that exam.
9. Completeness, neatness and legibility in assignments, exams and projects are mandatory. Sloppiness will be penalized at instructor’s discretion.

* Students who have University sanctioned activities or military obligations must provide advance notice if exam dates conflict with those activities for exam make-up purposes.

GRADING POLICY

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Assignments</td>
<td>25 %</td>
</tr>
<tr>
<td>Exam 1</td>
<td>10 %</td>
</tr>
<tr>
<td>Exam 2</td>
<td>15%</td>
</tr>
<tr>
<td>Project 1*</td>
<td>20%</td>
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<tr>
<td>Project 2*</td>
<td>30%</td>
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</tbody>
</table>

* Peer evaluation will be factored in the individual grade for project
GRADING SCHEDULE

Grade is assigned based on performance, NOT on “effort”. Projects are assessed based on overall quality of document and engineering considerations as well as on relative comparison with the rest of the class. Minimalist effort will produce minimal credit.

<table>
<thead>
<tr>
<th>Grade Range</th>
<th>Grade</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>90 – 100</td>
<td>A</td>
<td>Mastery of skills and clear understanding of concepts</td>
</tr>
<tr>
<td>80 – 89</td>
<td>B</td>
<td>Reasonable skills and basic understanding of most concepts</td>
</tr>
<tr>
<td>70 – 79</td>
<td>C</td>
<td>Acceptable skills and misunderstanding of important concepts</td>
</tr>
<tr>
<td>60 – 69</td>
<td>D</td>
<td>Minimum of required skills and minimal understanding of basic concepts</td>
</tr>
<tr>
<td>0 – 59</td>
<td>F</td>
<td>Unacceptable level of skills and/or of understanding of basic concepts</td>
</tr>
</tbody>
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Mid Term Grade:
All students will receive a mid-term grade that will be recorded in Star on October 10/2018. This grade will reflect the performance up to the date of entering the grade (based on the grade weights on graded items) and will not necessarily represent 50% of the final grade.

<table>
<thead>
<tr>
<th>IMPORTANT DATES</th>
<th>Event</th>
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<tbody>
<tr>
<td>Wednesday 15, 2018</td>
<td>First Day of Classes</td>
</tr>
<tr>
<td>August 21, 2018</td>
<td>Last day to register, add/drop courses</td>
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<tr>
<td>September 3, 2018</td>
<td>Labor Day Recess (University Closed)</td>
</tr>
<tr>
<td>October 4, 2018</td>
<td>Mid Semester Reports Due (all students)</td>
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<tr>
<td>October 12, 2018</td>
<td>Fall Break</td>
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<td>October 23, 2018</td>
<td>Last day to drop a class</td>
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<tr>
<td>November 6, 2018</td>
<td>Election Day (no classes)</td>
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<tr>
<td>November 17-25, 2018</td>
<td>Fall Recess</td>
</tr>
<tr>
<td>December 5, 2018</td>
<td>Last Day to withdraw from the University</td>
</tr>
<tr>
<td>December 6, 2018</td>
<td>Last day of class</td>
</tr>
<tr>
<td>December 7, 2018</td>
<td>Preparation day for Finals</td>
</tr>
<tr>
<td>December 11, 2018 (2:00-4:00 pm)</td>
<td>Final Exam for MW Lab Section</td>
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<tr>
<td>December 11, 2018 (8:00 – 10:00 am)</td>
<td>Final Exams for TR Lab Section</td>
</tr>
<tr>
<td>December 15, 2018</td>
<td>Commencement</td>
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</tbody>
</table>

STATEMENT ON 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 West Virginia University 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 MAE Policy of Academic Integrity will be used to address instances of academic dishonesty according to the following table:

**MAE POLICY OF ZERO TOLERANCE FOR ACADEMIC DISHONESTY**

<table>
<thead>
<tr>
<th>Case</th>
<th>Violation</th>
<th>Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cheating on an assignment</td>
<td>Zero in the assignment + Letter reduction in final grade</td>
</tr>
<tr>
<td>2</td>
<td>Cheating on a term project</td>
<td>Failure in the Course + UF recommendation</td>
</tr>
<tr>
<td>3</td>
<td>Cheating on an exam</td>
<td>Failure in the Course + UF recommendation</td>
</tr>
<tr>
<td>4</td>
<td>Cheating on the final</td>
<td>Failure in the Course + UF + Susp. recommendation</td>
</tr>
<tr>
<td>5</td>
<td>Other (doc. alteration, tampering with records, etc.)</td>
<td>F, Rec: UF, Probation, Suspension, Dismissal</td>
</tr>
<tr>
<td>6</td>
<td>Disrespect, harassing of any kind to instructor or TA</td>
<td>Police report, UF, Suspension or Dismissal</td>
</tr>
<tr>
<td>7</td>
<td>Physical contact, or threat of any kind</td>
<td>Police report + Expulsion</td>
</tr>
</tbody>
</table>

FORBIDDEN: The use of smart devices (smart-phones, pads, or wearable devices) in exams or quizzes, and the use of programmable calculators as directed by instructor.

**INCLUSIVITY 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; please see [http://diversity.wvu.edu](http://diversity.wvu.edu).