

**Semester** Spring 2023  
**Course Number** Technical Elective  
**Course Title** Application of Finite Element Analysis (FEA) for Mechanical Design

**Instructor** Professor Ping C. Sui, Ph.D  
Office: 4-222  
E-mail: ping.sui@scupi.cn

**Teaching Assistant** Christine Hua  
E-mail: [huayingting0418@stu.scu.edu.cn](mailto:huayingting0418@stu.scu.edu.cn)

**Office Hours** Wednesday 13:00-17:00  
Thursday 13:00-17:00

**Lecture Time Classroom** Friday 8:15-11:00  
Zone 2-212

**Prerequisites** Engr 0135 Statics and Mechanics of Materials 1  
Engr 0145 Statics and Mechanics of Materials 2  
ME1028 Mechanical Design 1 (Recommended)

**References** ANSYS Workbench User's Guide  
([https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/wb2\\_help/wb2\\_help.html%23wb2\\_help](https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/wb2_help/wb2_help.html%23wb2_help) )

ANSYS Mechanical User's Guide  
([https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/wb\\_sim/ds\\_Home.html](https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/wb_sim/ds_Home.html))

ANSYS Element Reference  
([https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/ans\\_elem/Hlp\\_E\\_LIBRARY.html](https://ansyshelp.ansys.com/account/secured?returnurl=/Views/Secured/corp/v201/en/ans_elem/Hlp_E_LIBRARY.html))

**Course Description** This course is a 3-credit hour class.

The learning objective of the course is to provide students the knowledge of applying FEA technique in structural analysis of mechanical components. The ultimate goal is for students to develop a proper protocol while using FEA to assess the failure risks of a mechanical component. The teaching will consist the following elements:

- hands-on training of using ANSYS Mechanical for structural analysis,
- frequent discussions for validity of the developed FEA model, and
- Interpretation of FEA analysis results and risk assessment against presumed failure modes.

Week	Date	Course Outline	In-Class Exercise/Workshop	Homework/Assignment
1	Feb 24	00. Course Introduction		
2	Mar 03	01. Discrete Model for Finite Element Analysis 02. Introduction of ANSYS Workbench (WB)	WS.01 Uniaxial Tensile Test	Reading Assignment 01 Reading Assignment 02 Lab Assignment 01
3	Mar 10	02. Introduction of ANSYS Workbench (WB)	WS.01 Uniaxial Tensile Test	Lab Assignment 02

4	Mar 17	03. ANSYS WB Mechanical Basics	WS.02 Rectangular Beam	Lab Assignment 03
5	Mar 24	03. ANSYS WB Mechanical Basics (Reaction Probe for Force, Moment) 03B. Mirror Symmetry, Axial Symmetry	WS.03 Half-Model of Tensile Specimen In-Class Exercise 02 (Axi-symmetry Practice)	Lab Assignment 04 Compression Member
6	Mar 31	04. General Preprocessing/Post-processing 03A. Failure Assessment	WS04A Named Selection BCs WS04B Coordinate System (Radial Deformation) WS04C Coordinate System (Inclined Force) WS.04D Construct Geometry (Surface)	Lab Assignment 05 Triangular Plate
7	Apr 07	<b>Section Exam 01</b>		
8	Apr 14	05. Mesh Control in ANSYS Mechanical	WS05A Flat Plat with Circular Hole 0501 Hex/Tet Mesh Control	Lab Assignment 06 Mesh Control
9	Apr 21	06. Mesh Evaluation, Error Estimation and Convergence Check	WS.06A Arm Mesh WS.06C Fillet Stress Concentration	Lab Assignment 07
10	Apr 28	06. Error Estimation and Stress Singularity	0601 2D Triangular Plate Simulation 0602 2D Simulation (Stress Concentration)	Lab Assignment 07
11	May 05	LN07 Line Modeling for Beam Analysis	Workshop WS.07A	Lab Assignment 08
12	May 12	LN08 Line Modeling for Truss Analysis	1001 2D Truss Analysis	Lab Assignment 09
13	May 19	<b>Section Exam 02</b>		
14	May 26	08. Remote Displacement and Force	0901 Cantilever Beam 0801 Remote Force Behavior Control 0802 Beam Bending + Axial Tension	Lab Assignment 10
15	Jun 02	09. Remote Displacement and Force 10. Connection Modeling Using Contacts	WS.09C Beam Analysis Using Remote BCs WS.10A Rod-Cylinder Contact	Lab Assignment 11
16	Jun 09	10. Connection Modeling Using Contacts 13. Modal Analysis	1101 Bearing-Pin Contact Analysis 1102 Press-Fit Cylinders	Lab Assignment 12

17	Jun 16	<b>Section Exam 03</b>		
18	Jun 23	<b>Final Project Presentations</b>		

In-Class Workshops	Hands-on practices assigned to students in class to promote discussions and keep students in-sync with course material during lecturing																																																
Homework	Problem sets will be distributed each week after the class. Each problem set is designed to build upon the material covered in the preceding lectures and recitations. Homework assigned in a particular class is due at 8 AM on the day of the next class period, unless otherwise posted. <u>Late HW will not be accepted.</u>																																																
Exams	No midterm and final exams. Replaced by four section exams given throughout the semester. The section exams will be in-class and hands-on type of testing to benchmark individual's proficiency in conducting a mechanical analysis using ANSYS Mechanical. All section exams will be comprehensive. <u>No make-up will be given for the missing exam.</u> Exams missed due to unpredictable events will be dealt with on a case-by-case basis.																																																
Final Project	Each student will select a mechanical system of their own interest and work independently to conduct structural analysis using the learned ANSYS knowledge.  Each student will submit a brief proposal to introduce the modeled system as well as to outline their project objective, technical approach and expected outcome.  Tentative proposal deadline: Nov 12, 2020.  Final project will be graded per technical challenges of the modeled problem, modeling skills, analysis details, and final report quality.																																																
Grades	In-Class Workshops: 15% Homework & Lab Assignments: 30% Section Exams: 40% Final Project: 15%  Grades will be assigned per following scales: 附件：等级成绩和百分成绩、绩点对照表  <table border="1" data-bbox="365 1395 1254 1675"> <tr> <td>字母等级</td> <td>A</td> <td>A-</td> <td>B+</td> <td>B</td> <td>B-</td> <td>C+</td> <td>C</td> <td>C-</td> <td>D+</td> <td>D</td> <td>F</td> </tr> <tr> <td>中文等级</td> <td colspan="2">优秀</td> <td colspan="2">良好</td> <td colspan="2">中等</td> <td colspan="3">合格</td> <td colspan="2">不合格</td> </tr> <tr> <td>百分制</td> <td>100-90</td> <td>89-85</td> <td>84-80</td> <td>79-76</td> <td>75-73</td> <td>72-70</td> <td>69-66</td> <td>65-63</td> <td>62-61</td> <td>60</td> <td>&lt;60</td> </tr> <tr> <td>绩点</td> <td>4</td> <td>3.7</td> <td>3.3</td> <td>3</td> <td>2.7</td> <td>2.3</td> <td>2</td> <td>1.7</td> <td>1.3</td> <td>1</td> <td>0</td> </tr> </table>	字母等级	A	A-	B+	B	B-	C+	C	C-	D+	D	F	中文等级	优秀		良好		中等		合格			不合格		百分制	100-90	89-85	84-80	79-76	75-73	72-70	69-66	65-63	62-61	60	<60	绩点	4	3.7	3.3	3	2.7	2.3	2	1.7	1.3	1	0
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Class Attendance	Students are expected to attend every class period. Early is on time, on time is late. As a courtesy to your fellow classmates, be punctual and arrive no later than the class starting time.																																																
Academic Honesty	All of us are equally responsible for ensuring a fair and positive learning environment. Students are permitted to discuss homework assignments together, but should do their own work when preparing a problem solution. All exams are to be completed without unauthorized assistance. Any student caught cheating on an assignment or exam will receive disciplinary action, up to and including receiving a grade of "F" for the course.																																																