ENGS 298-A: Computer Aided Engineering

Course Information:

Instructor: Dr. Rajesh Vuddandam (Dr. Raj)
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Office: Trexler 270J; **Phone**: 540-375-2010;
Office Hours: MWF 10:45am -12pm & 1pm to 2pm or by appointment
Lecture time: M 4:00 – 5:30 pm; **Lecture Room**: Trexler 273; **Units**: 0.5

Course Description:

This introductory course explores how Computer Aided Engineering (CAE) software is used to enhance the design process. Through practical tutorials, students will learn to build basic digital prototypes, apply loads and constraints, and interpret simulation results for stress, deformation, and factor of safety. Focusing on hands-on modeling, students will learn to create prototypes and develop a practical understanding of how simulation guides design decisions and verifies mechanical performance.

Course Prerequisites:

ENGS-191 - Must be completed prior to taking this course.

Textbook and/or Resource Materials:

- (Required) Hardware & Software: You are required to have regular access to a personal laptop capable of running Autodesk Educational Software or to utilize the computers in the ENGS Computer Labs (Trexler 274 or 273).
- (Required) Software Account: A free Autodesk Education account is mandatory. This account is required to install the necessary software and access all assigned Autodesk training modules.
- Course Documents: All supplementary handouts, lecture notes, and assignment guides will be posted and accessible through INQUIRE.

ABET Criteria 3 Student Outcomes:

The learning outcomes for this course are explicitly mapped to ABET Criterion 3 Student Outcomes (1-7). This course is designed to support the attainment of ABET Student Outcomes 1, 2, 3, and 6. Using industry-standard software, students will apply principles of statics and materials to create and analyze digital prototypes, propose design solutions based on simulation results, and communicate their findings, thereby developing essential skills for modern engineering practice.

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, and 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.

Course Learning Outcomes:

Upon successful completion of this course, students will be able to:

1. Apply engineering principles to create and constrain digital models of mechanical components for

analysis. *(ABET SO1)*
2. Utilize CAE software (Autodesk Fusion/Inventor) to perform linear static stress simulations and interpret the results of stress, deformation, and safety factors. *(ABET SO1, SO6)*
3. Compare simulation outputs to analytical hand calculations and physical reasoning to validate models and identify potential errors. *(ABET SO1, SO6)*
4. Recommend design improvements, such as shape or material modifications, based on simulation feedback to meet specified performance criteria. *(ABET SO2)*
5. Effectively communicate analysis assumptions, procedures, and results through clear comprehensive reports. *(ABET SO3)*

Inquire:

Inquire Access (required) – Inquire is a learning management system that will be used to post all course activity handouts, assignments, project details, syllabus etc., and can be accessed using Roanoke college's student login credentials using the following link https://inquire.roanoke.edu/

Grading Policy:

Class grades will be calculated according to the following distribution

Category	**% Distribution**
Attendance/Class Participation	5%
Autodesk Training Exercises	25%
Homework Assignments (Individual)	20%
Handouts (Individual)	20%
Midterm Exam (on building prototype)	15%
Final Exam - comprehensive (on prototype & stress analysis)	15%
Total	**100%**

The final grade will be assigned as follows, although the instructor reserves the right to lower the limits slightly at their discretion considering factors such as student attendance, class participation, and class performance.

Points	Grade	Points	Grade
<60	F	77-79	C+
60-62	D-	80-82	B-
63-66	D	83-86	B
67-69	D+	87-89	B+
70-72	C-	90-92	A-
73-76	C	≥93	A

Student Expectations & Course Format:

This course is structured to maximize hands-on learning with industry-standard software. Expect to dedicate a minimum of 12 hours of work each week, both inside and outside of class. Software proficiency is cumulative and experience based. Your competence with Autodesk Fusion and Inventor will be a direct result of the focused deliberate practice you commit during class-time and independent work. Your success is contingent on consistent, active engagement with all assigned materials and in-class activities. You are required to prepare for each session by completing the assigned Autodesk tutorials and reviewing the concept handouts provided. This foundational work is critical for you to participate effectively during our hands-on class time.
First Half Semester – Digital Modeling & Assembly: The initial weeks focus on developing core digital prototyping skills. You will use Autodesk Fusion 360 (mostly) and Autodesk Inventor (to some extent) to model components, create assemblies, and apply real-world constraints. Key learning will come from assigned Autodesk training materials and instructor-provided handouts.

Second Half Semester– Simulation & Analysis: The latter half transitions to applying engineering fundamentals through simulation. Instructor handouts will explicitly connect concepts from Statics and Strength of Materials to the CAE workflow. You will learn to set up and perform static stress analyses, interpret results, and validate designs using Autodesk Fusion 360 and Inventor.

Attendance Policy:
Regular attendance is required for this course. The instructor records attendance via INQUIRE, and it contributes directly to your final grade as detailed in the grading policy. Attendance is graded using the following point values: full attendance (**P**) = 2 points; late arrival or early departure (**L**) = 1 point; documented, excused absence (**E**) = 1 point; unexcused absence (**A**) = 0 points. Students must notify the instructor promptly of any excused absence and are personally accountable for all missed content and assignments. If you miss class for a college activity, please contact instructor to arrange a make-up plan (e.g., a different deadline or exam time). To protect your learning, the college recommends that total absences, across all reasons, stay below 20% of class meetings; coaches and instructors will work with you to help manage this limit. Also, read the late/make-up work policy section.

Class Participation:
This course emphasizes active, in-class collaboration, requiring thorough preparation before each session and engaged participation during class to succeed. Your grade is directly influenced by this participation and the completion of in-class activities, which cannot be made up without an excuse as defined in the Late/Makeup Work Policy. This approach ensures a deeper, practical understanding that passive consumption of materials cannot provide.

Autodesk Training Exercises:
These foundational exercises are your primary tool for building software proficiency. You will complete assigned modules from Autodesk's official training platform to learn the core workflows for modeling, assembly, and simulation in Fusion 360 and Inventor. Submission of single, legible PDF file to INQUIRE by the due date is required. Detailed instructions and all necessary resources will be posted and regularly updated on the course INQUIRE page.

Handouts:
This course utilizes handouts to deliver instructional content. These handouts bridge theoretical concepts from statics and materials to practical CAE applications. They contain targeted questions that require you to explain how engineering fundamentals directly inform your simulation setup and the interpretation of your results. Students are responsible for actively completing these handouts during class by adhering to the instructor's guidance and taking notes. Submission of single, legible PDF file to INQUIRE by the due date is required. Detailed instructions and all necessary resources will be posted and regularly updated on the course INQUIRE page.

Assignments:
Assignments are designed to help you apply and deepen your understanding of course material. These assignments provide step-by-step practice in applying software skills to model and solve specific engineering problems. You will follow guided instructions to build models, run analyses, and produce brief reports that document your process and findings. All work must be submitted as a single, legible PDF file through the INQUIRE platform by the specified due date. Detailed instructions and all

necessary resources will be posted and regularly updated on the course INQUIRE page.

Exams:
You will take one midterm exam and one comprehensive final exam on the dates listed in the course schedule. The midterm is a practical exam focused on digital prototyping, requiring you to build a constrained assembly from provided drawings. The comprehensive final exam requires you to perform a static stress analysis on a similar prototype, interpret the results, and justify a redesign to enhance its performance. Final examinations are scheduled at the times designated by the Registrar's Office. Make-up is only offered for excused reasons and requires advance notice (except in emergencies). Failure to obtain an excuse will result in a zero for the missed exam.

Projects:
While no projects are required for this course, students have the option to undertake a self-motivated project to deepen their understanding. To propose a project, identify a real-world problem where you can apply course principles. The instructor is available to advise on scope, methodology, and resources. This is an opportunity for comprehensive, applied learning beyond the standard curriculum.

Submission Policy:
Applicable to Training Exercises, Handouts, Assignments: All work must be submitted as a single, legible PDF file. This format is required to ensure the efficient and accurate grading of your work and for the secure storage of student materials, which may be used for official course and program accreditation purposes. Detailed instructions and all necessary resources will be posted and regularly updated on the course INQUIRE page.

If you need assistance with scanning, compiling, or organizing your work into a single PDF, please do not hesitate to ask for help well before the submission deadline.

Grading Consequence: Solutions that do not follow this prescribed structure and a single, legible pdf file rule will be returned without a grade or will receive zero credit unless student follows the instructions. This policy is in place to develop professional communication skills and ensure fair, efficient evaluation of your work.

Late/Make-up Work Policy:
Late submissions are not accepted without a valid, instructor-approved excuse. Students must proactively communicate in any circumstances that may delay their submission. The approval of any excuse and the granting of a makeup opportunity is solely at the instructor's discretion.

Teamwork:
There are no required team projects that contribute to the final course grade. The option to pursue a self-motivated project is available exclusively for students seeking to deepen their comprehension of the material through applied, real-world problem-solving. Completing such a project will enhance your learning but will not factor in your official grade calculation. The group project achieves two primary objectives:

1. Academic: To develop your ability to collect, analyze, and evaluate real-world physical measurements, including the management of errors and outliers.
2. Professional: To cultivate essential teamwork skills, including sharing ideas, managing

responsibilities, resolving conflicts, and providing constructive peer feedback.

Other Policies

Generative AI Usage:

In this course, using AI as a learning tool is permitted with restrictions. However, you should consider the following conditions/concerns:

- ✅ Permitted For: Brainstorming (ideation) and learning support.
- ❌ Not Permitted For: Generating content to be submitted as your own work.
- 📚 Citation: Always reference any AI tool you use for assistance.
- 🧠 Accountability: You must be able to explain and defend all your work.
- 📝 Exams: Absolutely no use of AI or any other external resources.

The goal of this course is to assess your understanding, not AI's output.

Academic Integrity:

Your learning and integrity are at the core of your RC education. For this reason, you must follow the rules outlined in the College AI policies. See www.roanoke.edu/academicintegrity

Writing Center:

The Writing Center Roanoke College, located on the Lower Level of Fintel Library (Room 5), offers free tutorials focused on writing projects and oral presentations for students working in any field. Writers and presenters at all levels of competence may visit the Writing Center at any point in their process, including brainstorming, drafting, organizing, editing, or polishing presentation skills—to talk with trained peer tutors in informal, one-on-one sessions. The Writing Center is open Sunday through Thursday from 4 to 9 PM. Simply stop in, or schedule an appointment at www.roanoke.edu/writingcenter. Questions? Email writingcenter@roanoke.edu or call 540-375-4949.

Subject Tutoring:

Subject Tutoring, located on the lower level of Fintel Library (Room 5), is open 4-9 PM, Sunday-Thursday. Subject Tutors are highly trained, current students who offer free, one-on-one (and small group) tutorials in over 80 courses taught at Roanoke College, including: Business, Economics, Mathematics, INQ 240, Modern Languages, Lab Sciences, and Social Sciences. Check out all available subjects and schedule 30- or 60-minute appointments at www.roanoke.edu/tutoring. If you have a question, feel free to stop by, or contact us at subject_tutoring@roanoke.edu or 540-375-2590.

Accessible Education Services (AES):

AES is located on the first floor of the Bank Building. AES provides reasonable accommodation to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of disability along with recommendations from the qualified specialist. Please contact Dustin Persinger, Assistant Director of Academic Services for Accessible Education, at 540-375-2248 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodation for this semester, please contact Dustin Persinger at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester. The testing center, also located on the first floor of the Bank Building, can be reached at 540-375-2247. https://www.roanoke.edu/inside/aes

Student Health and Counseling Services (SHCS):

Student Health & Counseling Services supports students through in-person health appointments. Please see https://www.roanoke.edu/shcs for more information and to access services.

Tentative Course Schedule:

The following schedule is tentative and may be adjusted. The official course schedule, assignments, and announcements will be maintained on the Inquire LMS platform, which students are responsible for monitoring regularly.

Week	Primary Topic / Module Focus	Key Activities & Deliverables
Part A — Building the Digital Prototype		
1 (Jan 12)	Course Intro & Syllabus	
2 (Jan 19)	Jan 19: No Class (MLK Jr. Day).	
3 (Jan 26)	Interface & Basic Part Creation	• Navigate the Fusion 360 UI. • Create simple sketches with constraints. • Generate 3D parts using Extrude and Revolve.
4 (Feb 2)	Intermediate Sketching & Modeling Tools	• Apply advanced sketch tools (Offset, Pattern, Trim). • Use modeling features like Hole, Fillet, Chamfer, Shell, and Pattern.
5 (Feb 9)	Assemblies & Motion	• Build assemblies - Bottom-Up &Top-Down approaches. • Apply joints to define relationships and motion. • Create basic animations and exploded views.
6 (Feb 16)	Catch up/ Midterm Exam Review	
7 (Feb 23)	Midterm Exam (In-Class Practical) – Will be creating an assembly (bottom-down approach)	
8 (Mar 1-8)	Spring Break – No Classes	
9 (Mar 9)	Technical Drawings & Documentation	• Generate standard, section, and detail drawing views. • Annotate drawings with dimensions, centerlines, and a parts list. • Populate a title block.
Part B — Performing Stress Analysis & Simulation		
10 (Mar 16)	Intro to Simulation Workspace	Simulation Prep & Setup - Applying materials, defining loads and constraints (Fixtures) based on static equilibrium.
11 (Mar 23)	Running Simulations & Interpreting Results	Running analyses, interpreting stress and displacement contour plots, and understanding safety factor.
12 (Mar 30)	Mesh Convergence & Model Validation	Modifying mesh settings, checking for stress singularities, and validating models against hand calculations
13 (Apr 6)	Design Analysis & Iteration	Performing "what-if" studies (e.g., changing geometry or material) to improve performance. Guided redesign exercise.
14 (Apr 13)	Introduction to CAM Fundamentals	
15 (Apr 20)	Final Exam Review	In-class Practical: Conduct a full static stress analysis on a provided assembly, interpret results, and submit a report with a justified redesign recommendation.
Final Exam – Thursday, April 23rd – 6pm to 9pm		