Mechanical and Industrial Engineering Department
ME635 Computer Aided Design **3 Credits**

NJIT New Jersey's Science & Technology University

COURSE OUTLINE

Prerequisites ME-616 and ME-622 or department approval.

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Office Hours Tuesday 4:00 – 5:30 pm & By Appointment

Textbook Creo Parametric 9.0 Advanced Tutorial By Roger Toogood, SDC Publications, 2022
ISBN: 978-1-63057-461-1

Reference Mastering CAD/CAM by I. Zeid, McGraw-Hill, New York, 2005
ISBN 0-07-286845-7

Course Description This course introduces various concepts of CAD (Computer-Aided Design), CAE (Computer-Aided Engineering), and CAM (Computer-Aided Manufacturing) as applied to Mechanical Engineering design problems. Topics include solid modeling, assembly, creating detailed drawings of solid models and production drawings, Finite element analysis, manufacturing models, and generating cutter location data (CL Data) in Numerical Control machining, such as turning and milling machines. The CAE component includes static, thermal, buckling, and modal analyses, mesh convergence, verification, and validation practices. The CAM component covers turning and milling sequences, toolpath planning, machining parameters, fixtures, and toolpath verification. Students will also explore Optimization, generative design, design for manufacturability, and design for additive manufacturing. The laboratory component involves the use of current CAD/CAM/CAE software packages. Makerspace prototyping activities will provide hands-on exposure to an end-to-end design and manufacturing pipeline.

Grading Scheme & Policies:

Homework and Design challenges	55%
Lab work & Cart Project	20%
Final Project	20%
Projects	5%
E-Portfolio	2% (Bonus)

Course Policies:

1. Attending class, completing assignments on time, and keeping up with the class material are essential for success in this course and in college. Generally, late or missed assignments **will not** be accepted except for legitimate **(pre-approved when possible)** reasons as determined by the instructor. The method of handling late or missed work is determined by the instructor.
2. **Missing more than 4 classes will lead to an 'F' grade in the course.** Exceptions will only be made for cases of excused absences supported

by relevant documentation submitted to and verified by the Office of the Dean of Students.

3. **Attending progress meetings scheduled throughout the semester is mandatory**
4. **ANY FORM OF CHEATING ON ASSIGNMENTS OR EXAMS WILL RESULT IN AN 'F' FOR THE COURSE**. This includes looking at another person's exam or copying another person's work for exams or assignments.
5. NJIT honor code will be used for all situations that involve cheating, copying, misrepresentation of student work, and misrepresentation of student information, and any violations will be brought to the immediate attention of the Dean of Students **(visit http://www.njit.edu/academics/honorcode.php).**
6. Weekly assignments are to be turned in by the due date.
7. The **part file** for the assignment is required to be submitted to get credit for the assignment. Non-submission of the part file will lead to a loss of grade for the assignment.
8. Weekly assignments are due on the first meeting of the class for the week (Monday or the appropriate first day of class for the particular section) **BEFORE** the start of the Lecture. Assignments turned in after the lecture begins are considered late.
9. **Assignments that are more than 2 weeks late will not be accepted**.
10. Point deduction – Late Assignments: 1-Week-20%, 2-Weeks-25%
11. **At least 60% of the homework has to be submitted for a passing grade.**
12. Not submitting the Cart project and the final projects will lead to an 'F' in the course.
13. Attendance, attitude, class participation, and effort can and will be used to change borderline grades up or down.
14. For special accommodation, students must approach the Office of Accessibility Resources and Services (OARS).
15. For issues regarding access to adequate computing equipment or high-speed internet access, please get in touch with the Office of the Dean of Students.
16. For any modifications or deviations from the syllabus throughout the course of the semester, the instructor will consult with students, and the students must agree to.

ACADEMIC INTEGRITY

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member

of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.** If you have any questions about the code of Academic Integrity, please get in touch with the Dean of Students Office at dos@njit.edu"

Administration of Exams

- Exams will be administered using either a combination of Respondus + Lockdown Browser and Webex or through ProctorU Review+.
- Students need to have access to a laptop to be able to take the exam using the tools mentioned above.
- NJIT honor code will be strictly adhered to; any violations will be processed through the office of the Dean of Students.

NJIT Makerspace:

As a part of this course, students will be completing the training in the following Makerspace courses:

- Make 101 - Introduction to the Makerspace (This course introduces users to the policies and safety procedures of the space and provides basic training for simple hand tools)
- Make 103 - Introduction to 3D Printing (Briefly covers the basics of 3D printing, including basic maintenance and operation, model preparation and slicing, starting, monitoring, and removing a print)

Tentative Course Outline:

Week 1:
Introduction course overview
Introduction to Creo Parametric and SolidWorks; Basics of Solid Modeling. Design Intent, Cart Project Introduction
Software - Creo Parametric; SolidWorks
Assignments: Creo Cart Project parts:

- Handle_pin;
- Front_spr_plate;
- Arm_vbrack;
- Arm_brack;
- Front_spring.

Week 2:
Part modeling: Sketching, Sketched Features, Applied Features, Design Strategies
Chapters 1 & 2
Software - Creo Parametric; SolidWorks
Assignments - Creo Cart Project parts:

- Arm_upper;
- Arm_lower;
- Fram_low_rgt;
- Fram_upp_rgt;
- Hub_cap; Lugnut.

Week 3:
Geometric modeling – Parametric curves: Straight lines, Quadratic curves, Cubic curves, and continuities. Introduction to Additive Manufacturing.
Part modeling: Applied Features, Reference Geometry, Patterned Geometry
Lesson 4 – Patterns and Family Tables
Software - Creo Parametric; SolidWorks; MATLAB, Cura
Assignments - Creo Cart Project parts:

- Cargo;
- Spring;
- Tubing;
- Wheel;
- Hex_bolt; Handle.

Week 4:
Geometric modeling – Parametric curves: B-Spline curves, NURB curves. Parametric surfaces: Parametric representation, B-spline surface
Lesson 5 - User-Defined Features
Software - Creo Parametric; SolidWorks; MATLAB
Assignments - Creo Cart Project parts:

- Wheel;

- Hex_bolt;
- Handle;
- Mount;
- Wheel_axle

Week 5:
Geometric transformations: Homogeneous coordinates, Scaling, Translation, Rotations
Chapter 5: Geometric Modeling Systems – Wireframe, Surface, and Solid Modeling Systems.
Assembly modeling
Software - Creo Parametric; SolidWorks; MATLAB
Assignments - Creo Cart Project parts:

- Front_pillar;
- Frame_front.prt;
- Frame_right.prt from
- frame_right.asm;
- Right_side.asm.

Week 6:
Geometric Modeling Systems – Nonmanifold, Assembly, and Web-Based Modeling Systems.
Design for additive manufacturing – Design for additive manufacturing using 3D scan data and Meshmixer
Orthographic projections. Drawings. Detailed drawing and dimensioning using ASME standards.
Software - Creo Parametric; SolidWorks, Meshmixer
Assignments - Creo Cart Project parts:

- Front Wheel Assembly with BOM (Bill of Materials);
- Detailed drawing of front_spr_plate;
- Detailed drawing of Front_wheel_brack.

Week 7:
Additive Manufacturing – Design for additive manufacturing
ANSYS Mechanical Topology Optimization – Optimization workflow in ANSYS Workbench. Complete end-to-end procedure from the original CAD file to the final calculation on the optimized shape. Optimization methods and general theory.
Creo Parametric – Generative design: Producing a generative engine algorithm-based, manufacture-ready design based on requirements and goals.
Surface modeling
Software - Creo Manufacture; SolidWorks Surfacing; Ultimaker CURA, ANSYS
Assignments –

- SolidWorks Surfacing
- Adv. Surface, Lofted Surface, Freeform Surface
- SolidWorks Simulation - Static Analysis

Week 8: Midterm Exam
Cart Project Due

ANSYS Mechanical Topology Optimization – Optimization methods and general theory. Basic and advanced definitions of Optimization for static applications. Geometry tools used in Spaceclaim to prepare and repair STL files.

SolidWorks Topology Optimization – Optimal design based on design and manufacturing constraints using the Topology Optimization tool in SOLIDWORKS Simulation
Additive Manufacturing – Design for additive manufacturing

Week 9:
Computer-Aided Manufacturing: Fundamental principles, CNC turning
Finite element analysis: Fundamental principles, SolidWorks Simulate
Generative design
Software - Creo Manufacture; SolidWorks Surfacing; SolidWorks Simulate

Assignments –

- SolidWorks Surfacing
- SolidWorks Simulation - Static Analysis
- Creo Manufacture - Basic Turning

Week 10:
Computer-Aided Manufacturing: Fundamental principles, CNC turning
Finite element analysis: Fundamental principles, SolidWorks Simulate, Mesh independence & convergence
Software - Creo Manufacture; SolidWorks Simulate, ANSYS
Assignments –

- SolidWorks Simulation:
- Static analysis, Thermal analysis, Buckling analysis
- ANSYS Workbench Static Structural Analysis
- Comparison between ANSYS and SolidWorks Simulate
- Creo Manufacture
- Thread and Groove turning; Profile, Face, Surface and Hole Making Milling

Week 11:
Computer-Aided Manufacturing: CNC milling
Finite element analysis: Advanced techniques, SolidWorks Simulate
Software - Creo Manufacture; SolidWorks Simulate
Assignments -

- SolidWorks Simulation:
- Large deformation, Modal analysis
- Creo Manufacture
- Milling sequence

Working on Projects

Week 12:
Computer-Aided Manufacturing: CNC milling using the Mill window and Mill volume sequence
Software - Creo Manufacture
Assignments - Expert Machinist, Mill Volume Sequence; Mill Window Sequence.
Working on Projects

Week 13:
Finite element analysis: Transient thermal analysis, SolidWorks Simulate

Week 14:
Standards Exchange Between CAD Systems – Direct method and Neutral files (IGES, DXF, and STEP) Creo Manufacture
Working on Projects

Week 15:
Final Exam and Projects Due

Homework related to the lectures will be assigned, collected, and graded.

The laboratory will be in MEC-219, and will have hands-on sessions to cover the basics and advanced features of Creo Parametric, Creo Simulate, SolidWorks, SolidWorks Simulate and ANSYS, Meshmixer.