

# Paul M. Rady Department of Mechanical Engineering Undergraduate Core Courses

As a student in Mechanical Engineering, you'll take courses that combine to form a strong foundation in many different areas. You can use this guide to learn about the classes you'll take, how they fit together, and how the content is applied in engineering practice. Clicking classes with an "MCEN" prefix below will bring you to the slide for that class. More information about the curriculum is available [on the ME website](#).

## MECHANICAL ENGINEERING CURRICULUM – BLUE 4-YEAR PLAN

1	GEEN 1400 (3) First-Year Engineering Projects	APPM 1350 (4) Calculus 1 For Engineers	PHYS 1110 (4) General Physics 1 (CR: APPM 1350)	MCEN 1030 (4) Engineering Computing (CR: APPM 1235 or APPM 1350)	Example Course (Credits) Course Name (PR: Prerequisites) (CR: Corequisites)
2	MCEN 1025 (4) Computer-Aided Design & Fabrication	MCEN 1024 (3) Chemistry of Energy & Materials	APPM 1360 (4) Calculus 2 For Engineers (PR: APPM 1350)	PHYS 1120 (4) General Physics 2 (PR: PHYS 1110) (CR: APPM 1360)	
3	Humanities & Social Science (3) Lower Division	MCEN 2000 (1) Mechanical Engineering as a Profession	APPM 2350 (4) Calculus 3 For Engineers (PR: APPM 1360)	MCEN 2024 (3) Materials Science (PR: MCEN 1024, PHYS 1110)	Math/Science Foundations (3)
4	Humanities & Social Science (3) Lower Division	Free Elective (3)	APPM 2360 (4) Linear Algebra & Differential Equations (PR: APPM 1360)	MCEN 3012 (3) Thermodynamics 1 (PR: APPM 1360)	MCEN 2063 (3) Mechanics of Solids (PR: MCEN 2023, APPM 1360)
5	Humanities & Social Science (3) Lower Division	MCEN 3025 (3) Component Design (PR: MCEN 1025, MCEN 2024, MCEN 2063)	MCEN 3030 (3) Computational Methods (PR: MCEN 1030, APPM 2360)	MCEN 3017 (3) Circuits & Electronics (CR: PHYS 1120) (CR: APPM 2360)	MCEN 3021 (3) Fluid Mechanics (PR: MCEN 2023, APPM 2350)
6	Writing Requirement (3)	MCEN 4026 (3) Manufacturing Processes & Systems (PR: MCEN 2024)	General Technical Elective (3)	MCEN 3022 (3) Heat Transfer (PR: MCEN 3012, MCEN 3021, APPM 2360)	MCEN 4043 (3) System Dynamics (PR: MCEN 4043, MCEN 3017, APPM 2360) (CR: MCEN 3030)
7	Humanities & Social Science (3) Upper Division	MCEN 4045 (3) Mechanical Engineering Design Project 1 (Fall Only)	MCEN 3032 (3) Thermodynamics 2 (PR: MCEN 3012, MCEN 3021, APPM 2360)	MCEN Technical Elective (3)	MCEN 3047 (4) Data/Measurements (PR: MCEN 2063, APPM 2360, PHYS 1140) (CR: Writing, MCEN 3030, MCEN 3022)
8	Humanities & Social Science (3) Upper Division	MCEN 4085 (3) Mechanical Engineering Design Project 2 (PR: MCEN 4045) (Spring Only)	Free Elective (3)	MCEN Technical Elective (3)	General Technical Elective (3)

**Key**

- Can be taken any semester pending completion of any applicable pre/co-requisites.
- Must be taken as a pre-requisite to MCEN 4045.
- Must take at least one of MCEN 3047, MCEN 3022 or MCEN 4043 as a pre-requisite to MCEN 4045. Remaining two can be taken as a co-requisite to MCEN 4045. All courses must be taken as a pre-requisite to MCEN 4085.
- Can be taken as a pre-requisite or co-requisite to MCEN 4045.
- Mechanical Engineering Design Project Sequence.

## MECHANICAL ENGINEERING CURRICULUM – GREEN 4-YEAR PLAN

Example Course (Credits) Course Name (PR: Prerequisites) (CR: Corequisites)	Humanities & Social Science (3) Lower Division	GEEN 1400 (3) First-Year Engineering Projects	MCEN 1024 (3) Chemistry of Energy & Materials	APPM 1350 (4) Calculus 1 For Engineers	
	Humanities & Social Science (3) Lower Division	Humanities & Social Science (3) Lower Division	PHYS 1110 (4) General Physics 1 (CR: APPM 1350)	APPM 1360 (4) Calculus 2 For Engineers (PR: APPM 1350)	MCEN 1030 (4) Engineering Computing (CR: APPM 1235 or APPM 1350)
	Free Elective (3)	PHYS 1140 (1) Experimental Physics (CR: PHYS 1120)	PHYS 1120 (4) General Physics 2 (PR: PHYS 1110) (CR: APPM 1360)	APPM 2350 (4) Calculus 3 For Engineers (PR: APPM 1360)	MCEN 1025 (4) Computer-Aided Design & Fabrication
	Humanities & Social Science (3) Upper Division	Free Elective (3)	MCEN 2023 (3) Statics & Structures (PR: APPM 1360, PHYS 1110)	APPM 2360 (4) Linear Algebra & Differential Equations (PR: APPM 1360)	MCEN 3017 (3) Circuits & Electronics (PR: PHYS 1120) (CR: APPM 2360)
	Writing Requirement (3)	MCEN 2063 (3) Mechanics of Solids (PR: MCEN 2023, APPM 1360)	MCEN 4043 (3) Dynamics (PR: MCEN 2023, APPM 1360)	MCEN 3012 (3) Thermodynamics 1 (PR: APPM 1360)	MCEN 4026 (3) Manufacturing Processes & Systems (PR: MCEN 2024)
	Humanities & Social Science (3) Upper Division	MCEN 3021 (3) Fluid Mechanics (PR: MCEN 2023, APPM 2350)	MCEN 3030 (3) Computational Methods (PR: MCEN 1030, APPM 2360)	MCEN 3025 (3) Component Design (PR: MCEN 1025, MCEN 2024, MCEN 2063)	MCEN 3047 (4) Data/Measurements (PR: MCEN 2063, APPM 2360, PHYS 1140) (CR: Writing, MCEN 3030, MCEN 3017)
	Math/Science Foundations (3)	MCEN 4045 (3) Mechanical Engineering Design Project 1 (Fall Only)	MCEN 3022 (3) Heat Transfer (PR: MCEN 3012, MCEN 3021, APPM 2360)	MCEN 4043 (3) System Dynamics (PR: MCEN 2043, MCEN 3017, APPM 2360) (CR: MCEN 3030)	MCEN Technical Elective (3)
	MCEN 3032 (3) Thermodynamics 2 (PR: MCEN 3012, MCEN 3021, APPM 2360)	MCEN 4085 (3) Mechanical Engineering Design Project 2 (Spring Only)	General Technical Elective (3)	General Technical Elective (3)	MCEN Technical Elective (3)

**Key**

- Can be taken any semester pending completion of any applicable pre/co-requisites.
- Must be taken as a pre-requisite to MCEN 4045.
- Must take at least one of MCEN 3047, MCEN 3022 or MCEN 4043 as a pre-requisite to MCEN 4045. Remaining two can be taken as a co-requisite to MCEN 4045. All courses must be taken as a pre-requisite to MCEN 4085.
- Can be taken as a pre-requisite or co-requisite to MCEN 4045.
- Mechanical Engineering Design Project Sequence.

Effective: Fall 2024

\*to open multiple classes when viewing online, hold ctrl or cmd while clicking each link to open multiple tabs

# MCEN 1024: Chemistry for Energy and Material Science

*Covers the basic physical and chemical fundamentals underlying the disciplines of energy and materials, with a focus on topics relevant to your mechanical engineering education. These fundamentals include atomic structure, stoichiometry, the periodic table, chemical bonding, states of matter, thermochemistry and chemical reactions.*

## Prerequisites

None

## Next Course in Sequence

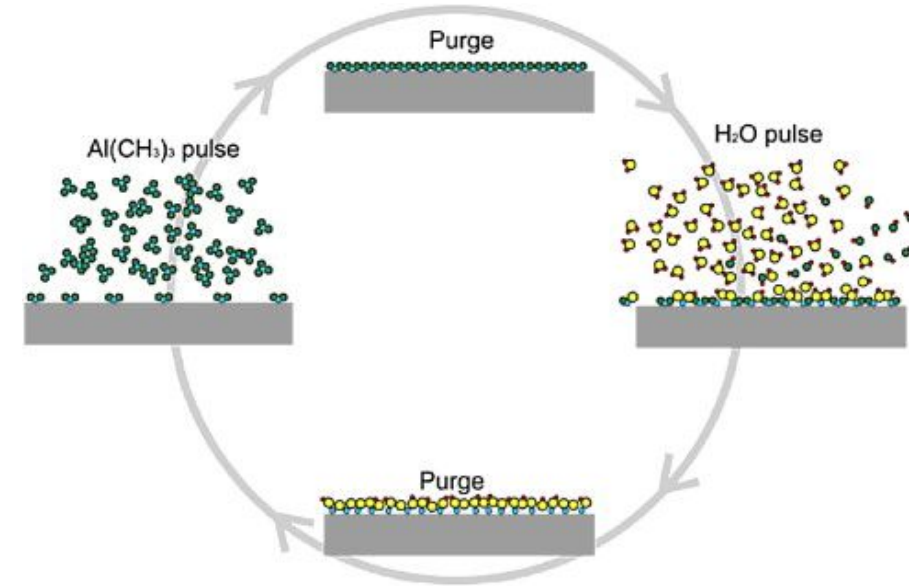
MCEN 2024 Material Science

**How this fits into the big picture:** As a mechanical engineer, you will work with a large variety of substances in order to complete complex products and processes. This course lays the college-level foundation for the atomic building blocks that make up engineering materials so that their properties are better understood in future classes/work.

**Example application:** [Forge Nano](#) uses atomic layer deposition processes to create accurate thickness and surface finishes on microelectronic components.

**Insider insight/things that are good to know in advance:** MCEN 1024 is one of the first ME courses that students complete here at CU. It is a great introduction course and more focused on the intersection between chemistry and mechanical engineering than the general chemistry courses engineering students are able to take. Additionally, MCEN 1024 does not have a corresponding lab section.

**Alternate options to complete:** CHEN 1201, CHEN 1211, or CHEM 1113



Atomic layer deposition (ALD) process

[www.sciencedirect.com/topics/chemical-engineering/atomic-layer-deposition](http://www.sciencedirect.com/topics/chemical-engineering/atomic-layer-deposition)

## If you enjoy this class, try:

MCEN 4183: Mechanics of Composite Materials  
MCEN 4194: Energy Conversion and Storage  
MCEN 4292: Materials and Devices in Medicine  
MCEN 4298: Intro to Polymers



# MCEN 1030: Introduction to Engineering Computing

*Introduces concepts and methods of computer programming with emphasis on applications to mechanical engineering. Includes vector/array manipulation, for/if/else/while loops, function definition, problem solving with programming. Covers MATLAB/Python with no previous experience expected.*

## **Prerequisites**

*APPM 1235 or APPM 1340 or APPM 1345 or APPM 1350 or MATH 1150 or MATH 1300 or MATH 1310*

## **Next Course in Sequence**

*MCEN 3030 Computational Methods*

**How this fits into the big picture:** Programming skills are critical for a modern engineer. This course teaches the basics of computer programming, with emphasis on MATLAB, a core programming language for later Mechanical Engineering classes, and Python, which is frequently used by the businesses that hire our graduates.

## **Insider insight/things that are good to know in advance:**

If you're considering a computer science minor, take CSCI 1300 instead, since MCEN 1030 is not accepted as an alternative to CSCI 1300 by the CSCI department.

**Alternate options to complete:** CSCI 1300





# MCEN 1025: Computer-Aided Design and Fabrication

*Introduces CAD software and relevant concepts, including modeling best practices, sketching, engineering drawing standards, geometric dimensioning and tolerancing, and an introduction to manufacturing methods. Final design project involves multiple fabrication techniques, including rapid prototyping.*

## **Prerequisites**

None

## **Next Course in Sequence**

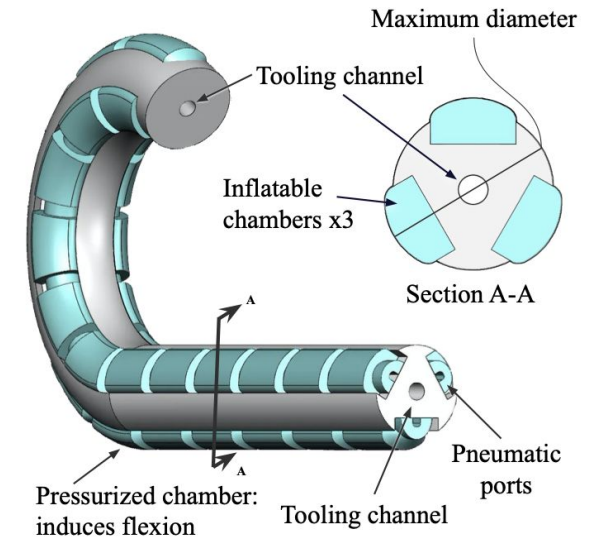
MCEN 3025 Component Design

**How this fits into the big picture:** Modeling and documenting a design is essential to the work that mechanical engineers do in almost every field. You can have the best idea for a solution, but if it cannot be communicated in a way that is understood by manufacturers and clients, the solution will never be successfully implemented. You will also get an introduction to multiple fabrication techniques, such as turning, milling, and sheet metal processes.

**Example application:** [Medtronic](#) uses CAD throughout their product design, documentation, and sustaining engineering processes for the medical device industry.

**Insider insight/things that are good to know in advance:** MCEN 1025 is a great skill-building class that will make you useful to potential employers, especially for internships. In this course, you will learn about principles of CAD and how to use SOLIDWORKS to create professional, high-quality engineering drawings. The course ends with a professional certification in the software.

**Alternate options to complete:** None



Soft Robot for Surgical Interventions  
designed by ME students for Medtronic  
[www.colorado.edu/mechanical/team-07-soft-robot-surgical-interventions](http://www.colorado.edu/mechanical/team-07-soft-robot-surgical-interventions)

## **If you enjoy this class, try:**

MCEN 4173: Finite Element Analysis  
MCEN 5045: Design for Manufacturability  
MCEN 5055: Advanced Product Design



# MCEN 2000: Mechanical Engineering as a Profession

*Provides an introduction to the profession of mechanical engineering specific topics addressed include career opportunities in mechanical engineering, internship search skills, expectations for professional behavior in the classroom and in industry, and current events/ethics topics relevant to the field. Course format may include additional evening/weekend activities.*

## **Prerequisites**

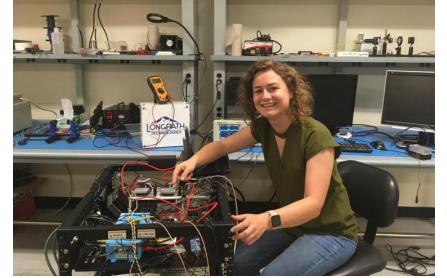
None

## **Next Course in Sequence**

MCEN 4045 Senior Design

**How this fits into the big picture:** The end goal of a degree in mechanical engineering is to take your experiences from college and apply them to your future goals, whether that is industry engineering, research, or something else entirely. This course focuses on helping you build the skills to form professional networks and advocate for yourself successfully in job applications or interviews. A team of student apprentices who have completed previous internships or research opportunities will help guide you through the experience and serve as peer mentors.

**Insider insight/things that are good to know in advance:** MCEN 2000 is very much a course where you get out what you put in. If you apply yourself and work hard at making professional connections and finding internship or research opportunities, you can set yourself up well to gain invaluable experiences. Many students leverage the lessons from this course in order to get their first internships or professional work experience during the summer after their second year.



MCEN 2000 TAs interning at Siemens Gamesa Renewable Energy, LongPath Technologies, ALD Nanosolutions, and L3Harris Technologies

[www.colorado.edu/mechanical/academics/professional-development/student-apprentices](http://www.colorado.edu/mechanical/academics/professional-development/student-apprentices)



# MCEN 2023: Statics and Structures

*Covers statics of particles, equivalent force systems, rigid bodies, equilibrium of rigid bodies in two and three dimensions, analysis of truss and frame structures, uniaxially-loaded members, distributed force systems and friction.*

## **Prerequisites**

APPM 1360 or equivalent  
PHYS 1110

## **Next Course in Sequence**

MCEN 2043 Dynamics  
MCEN 2063 Solids  
MCEN 3021 Fluids

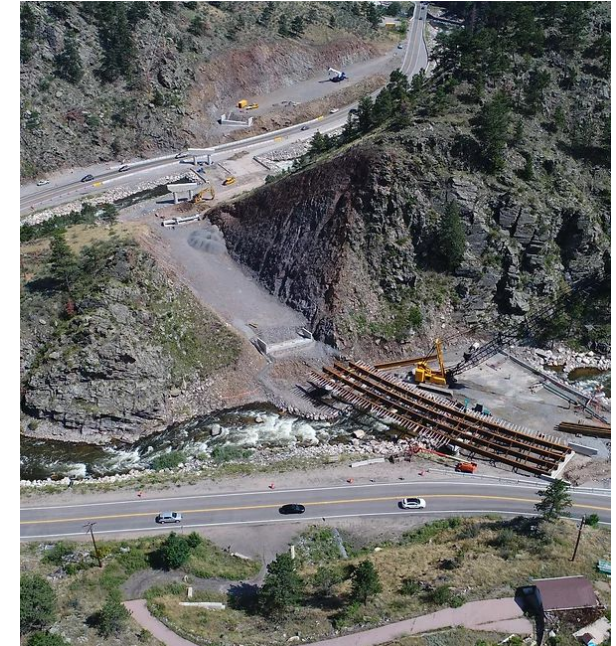
**How this fits into the big picture:** Statics and structures is another foundational ME course that explores some of the most common and recognizable applications of mechanical engineering such as trusses and simple machines. The tools in this course will later be used to analyze more complicated systems in future ME courses and projects.

**Example application:** [RockSol](#) is a civil engineering consulting group that provides expertise in several fields such as bridge and structural engineering and environmental services. They primarily work on projects within Colorado but have also contributed to work across the United States.

## **Insider insight/things that are good to know in advance:**

MCEN 2023 is usually one of the first courses you'll take that utilizes the ME homework format. Spending some extra time to get familiar with the format will not only save some time in the course, but also ensure your future work can be clear, communicable, and standalone.

**Alternate options to complete:** GEEN 2851, CVEN 2121, or  
ASEN 2701



RockSol consulted on US 34 Big Thompson Canyon construction starting in 2016

[www.rocksol.com/project-2](http://www.rocksol.com/project-2)





# MCEN 2024: Materials Science

*Provides an overview of the structure, properties and processing of metallic, polymeric and ceramic materials. Specific topics include perfect and imperfect solids, phase equilibria, transformation kinetics, mechanical behavior and material degradation. Approach incorporates both materials science and materials engineering components.*

## **Prerequisites**

MCEN 1024 or equivalent  
PHYS 1110

## **Next Course in Sequence**

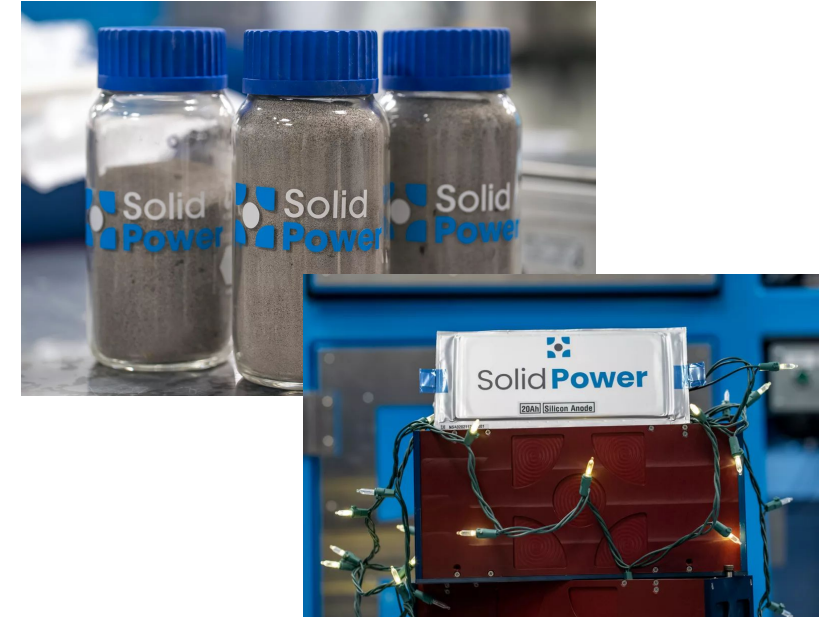
MCEN 3025 Comp Design  
MCEN 4026 Manufacturing

**How this fits into the big picture:** Materials play a crucial role in what engineering projects are physically possible to implement. So much so that entire “ages” of human civilization have been named after the cutting-edge material of the time (i.e. Bronze, Iron). Every day, new materials are being created and discovered, and with each addition, the possibilities of engineering and science are expanded.

**Example application:** [Solid Power](#) uses material science principles to create solid state batteries that are safer, store more energy, and are cheaper than current technologies.

**Insider insight/things that are good to know in advance:** MCEN 2024 builds off of the the knowledge base started in MCEN 1024 Chemistry for Energy and Material Science and helps to build intuition around the materials you will work with in your engineering career. It is highly beneficial to learn about material property trends and resources that you can refer back to when selecting specific materials in later years at CU Boulder or in industry/research.

**Alternate options to complete:** GEEN 3024



Battery material and example solid state battery  
[solidpowerbattery.com/](https://solidpowerbattery.com/)

## **If you enjoy this class, try:**

MCEN 4183: Mechanics of Composite Materials  
MCEN 4194: Energy Conversion and Storage  
MCEN 4292: Materials and Devices in Medicine  
MCEN 4298: Intro to Polymers



# MCEN 2043: Dynamics

*Covers dynamic behavior of particle systems and rigid bodies; 2-D and 3-D kinematics and kinetics; impulse, momentum, potential, and kinetic energy; and work, collision, and vibration.*

## **Prerequisites**

*MCEN 2023 or equivalent  
APPM 1360 or equivalent*

## **Next Course in Sequence**

*MCEN 4043 System  
Dynamics*

**How this fits into the big picture:** Dynamics focuses on the study of objects in motion. It allows mechanical engineers to understand the forces on objects in motion, so that they can anticipate how those forces will impact their design.

**Example application:** [Redwire](#) develops deployable space systems including antennas, solar arrays, and solar sails. Their engineers use principles covered in dynamics to ensure that their hardware will both deploy and function effectively in a space environment.

**Insider insight/things that are good to know in advance:** Because many of you will take this course immediately after taking Statics (MCEN 2023), you will be inclined to say that the sum of forces acting on an object is zero. Remember that in this class the acceleration is almost never zero and forces will rarely be in balance. You will get very good at drawing free-body diagrams!

**Alternate options to complete:** CVEN 3111, PHYS 3210, or ASEN 1022



Rendering of a helical L-band antenna  
[redwirespace.com/newsroom/roccor-creates-helical-l-band-antenna/?rdws=nnn.xffxcv.tfd&rdwj=3094](https://redwirespace.com/newsroom/roccor-creates-helical-l-band-antenna/?rdws=nnn.xffxcv.tfd&rdwj=3094) 1

## **If you enjoy this class, try:**

MCEN 4115: Mechatronics and Robotics 1  
MCEN 4157: Modeling of Human Movement  
CSCI 3302: Intro to Robotics





# MCEN 2063: Mechanics of Solids

*Covers shear force and bending moment, torsion, stresses in beams, deflection of beams, matrix analysis of frame structures, analysis of stress and strain in 2-D and 3-D (field equations, transformations), energy methods, stress concentrations and columns.*

## **Prerequisites**

*MCEN 2023 or equivalent  
APPM 1360 or equivalent*

## **Next Course in Sequence**

*MCEN 3025 Component Design*

**How this fits into the big picture:** Failure, specifically material or component failure, is a critical part of engineering. Designs need to have predictable and safe modes of failure to prevent injuries and expensive damages. In order to understand these modes, it is first important to understand the mechanics of internal reactions to loads, and the types of features that will have the biggest impacts on those reactions.

**Example application:** [Siemens Gamesa](#) analyzes the potential stresses within their turbine blades due to the elevated risk for both extreme and fatigue failure under dynamic loading.

**Insider insight/things that are good to know in advance:** MCEN 2063 combines a lot of the material from MCEN 2023 Statics and MCEN 2024 Materials Science to explain topics like deflection and torsion which later tie into material failure. The course provides many shorthand approximation techniques that will be useful in “back-of-the-napkin” calculations when first brainstorming solutions or determining where critical failure points are likely located.

**Alternate options to complete:** CVEN 3161



Offshore wind turbines often experience significant forces from strong wind  
[www.windpowerengineering.com/a-u-s-offshore-wind-market-update-from-siemens-gamesa/](http://www.windpowerengineering.com/a-u-s-offshore-wind-market-update-from-siemens-gamesa/)

## **If you enjoy this class, try:**

MCEN 4133: Tissue Biomechanics  
MCEN 4173: Finite Element Analysis  
MCEN 4174: Failure of Engineering Materials  
MCEN 4293: Mechanics of Soft Matter



# MCEN 3012: Thermodynamics

*Explores fundamental concepts and basic theory, including first and second laws of thermodynamics, properties, states, thermodynamic functions and cycles.*

## **Prerequisites**

*APPM 1360 or equivalent*

## **Next Course in Sequence**

*MCEN 3022 Heat Transfer  
MCEN 3032 Thermo 2*

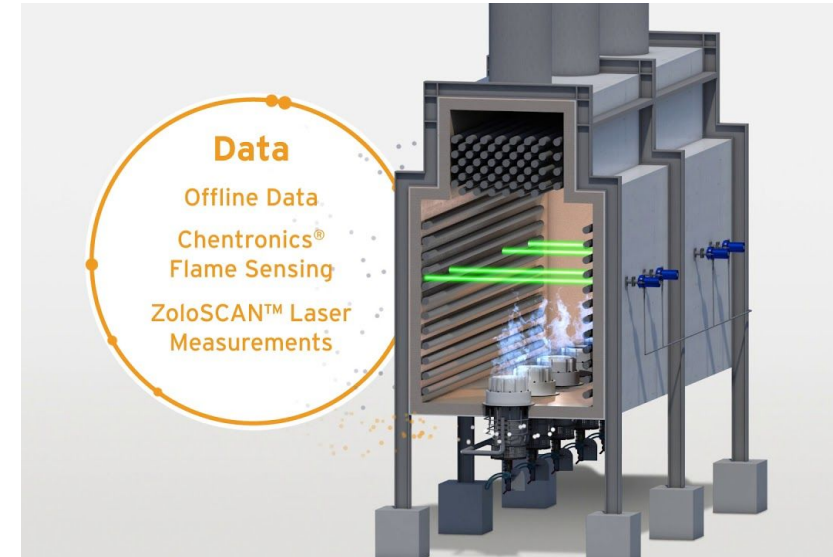
**How this fits into the big picture:** As a mechanical engineer, you will often find yourself working with systems that manipulate energy to accomplish a goal. MCEN 3012 lays the foundation for understanding systems through the approach of energy balances. This first level understanding allows you to quickly analyze the effectiveness and feasibility of thermodynamic processes.

**Example application:** [John Zink Hamworthy](#) is global leader in the emissions control field with over 1,000 patents in a variety of fields. Their leading products deal with designing smart combustion processes.

## **Insider insight/things that are good to know in advance:**

The first section of MCEN 3012 Thermodynamics builds a foundation of terminology, types of energy, and other key building blocks. Making sure you understand each of these core principles will make recognizing components of a system and building a representative energy balance much easier later in the semester.

**Alternate options to complete:** GEEN 3852, AREN 2110, or EVEN 3012



John Zink Hamworthy Smart Combustion  
Process Design: How it Works

[www.youtube.com/watch?v=0BUFXL4Z0f4](https://www.youtube.com/watch?v=0BUFXL4Z0f4)

## **If you enjoy this class, try:**

MCEN 4152: Combustion

MCEN 4228: Thermofluids Lab

MCEN 4012: Renewable Fuels, Fuel Cells,  
and Internal Combustion Engines



Paul M. Rady  
Mechanical Engineering  
UNIVERSITY OF COLORADO BOULDER

[www.colorado.edu/mechanical/](http://www.colorado.edu/mechanical/)

# MCEN 3017: Circuits and Electronics

*Introductory course covers analysis of electric circuits by use of Ohm's law, network reduction, node and loop analysis, Thevenin's and Norton's theorems, DC and AC signals, transient response of simple circuits, transfer functions, basic diode and transistor circuits and operational amplifiers.*

## **Prerequisites**

*APPM 2360 or equivalent*

## **Next Course in Sequence**

*MCEN 4043 System*

*Dynamics*

*MCEN 4045 Senior Design*

**How this fits into the big picture:** Many mechanical engineering jobs nowadays require some type of interfacing with electronic components or tools. MCEN 3017 builds off of the basic electrical foundation provided in Physics 2 and explores some of the circuits and electronics such as low pass filters that you may see in your career or in school.

**Example application:** [Xtreme Power Conversion](#) designs and manufactures a large number of systems that provide and safeguard power distribution. These systems are at a crucial junction between electrical and mechanical disciplines as capabilities are balanced with constraints such as heat management.

**Insider insight/things that are good to know in advance:** In addition to a lecture portion, MCEN 3017 has a lab portion of the class where you can build the circuits and test the electronics you are learning about. This is a great opportunity to understand the material at a deeper level and gain hands on experience you can draw on when faced with similar problems in the future.

**Alternate options to complete:** GEEN 3010 or ECEN 2250+2260+2270 (must take all three)



Portable cooling unit designed and manufactured by XPC

<https://www.xpcc.com/products/xc/>

**If you enjoy this class, try:**

MCEN 4115: Mechatronics & Robotics

MCEN 4195: Bioinspired Robotics

MCEN 5228: Flexible Electronics

MCEN 5636: MEMS





# MCEN 3021: Fluid Mechanics

*Examines fundamentals of fluid flow with application to engineering problems. Topics covered include fluid statics and kinematics, Bernoulli equations, laminar and turbulent viscous boundary layers, laminar and turbulent pipe flow, and conservation equations for mass, momentum and energy.*

## **Prerequisites**

MCEN 2023 or equivalent  
APPM 2350 or equivalent

## **Next Course in Sequence**

MCEN 3022 Heat Transfer  
MCEN 3032 Thermo 2

**How this fits into the big picture:** Fluids are utilized in many engineering applications such as cooling combustion engines, oxygen transport in the human body, and designing wind turbines to harvest renewable energy. Predicting the effects and behavior of fluids is crucial to understanding how to optimize engineering designs.

**Example application:** [Micro Motion](#) makes flow meters that use the Coriolis effect to directly and accurately measure flow speed. Their products are used in many industries including water systems, energy production, wood/paper products, and food/beverage manufacturing.

## **Insider insight/things that are good to know in advance:**

MCEN 3021 is significantly different from many of the previous undergrad ME courses. Be prepared to learn a large variety of new concepts and applications. Especially for this class, spending some extra time understanding the course material at the beginning will yield huge dividends throughout the rest of the semester.

**Alternate options to complete:** AREN 2120, CHEN 3200, or CVEN 3313



Micro Motion Coriolis Flowmeter

[www.emerson.com/en-us/automation/micro-motion](http://www.emerson.com/en-us/automation/micro-motion)

## **If you enjoy this class, try:**

MCEN 4151: Flow Visualization  
MCEN 4231: Computational Fluid Dynamics  
MCEN 4111: Intro to Microfluidics  
MCEN 4228: Fluid Mech in the Human Body



# MCEN 3022: Heat Transfer

*Studies fundamentals of heat transfer by conduction, convection, and radiation. Emphasizes problem formulation and selection of appropriate solution techniques. Provides applications to modern engineering systems, which may include energy, biological, environmental, and materials engineering problems.*

## **Prerequisites**

*MCEN 3021 or equivalent  
MCEN 3012 or equivalent  
APPM 2360 or equivalent*

## **Next Course in Sequence**

*MCEN 4045 Senior Design*

**How this fits into the big picture:** MCEN 3022 investigates the three modes of heat transfer: conduction, convection, and radiation. Within each mode, common systems are explored and first level analysis is carried out in order to approximate the behavior of those systems.

**Example application:** [Electro-Mechanical Products \(EMP\)](http://electromechanicalproducts.com) is a global leader in the manufacture of thermal management products. Their engineers consult with customers in order to turn their thermal management needs into manufacturable and cost effective solutions.

**Insider insight/things that are good to know in advance:** Engineering Equation Solver (EES) is an extremely valuable tool for MCEN 3022. The built in property and scenario functions allow you to quickly model a system utilizing the proper heat transfer relationships based on user defined inputs.

**Alternate options to complete:** CHEN 3210



EMP Cooling Coil for Thermal Management

[electromechanicalproducts.com/thermal-management/](http://electromechanicalproducts.com/thermal-management/)

## **If you enjoy this class, try:**

MCEN 4032: Sustainable Energy

MCEN 4228: Thermofluids Lab

MCEN 4228: Intro to Nanoscale Transport

MCEN 5042: Grad Heat Transfer



# MCEN 3025: Component Design

*Application of mechanics and materials science to the detailed design of various machine elements including shafts, bearings, gears, brakes, springs, and fasteners. Emphasizes application and open-ended design problems.*

## **Prerequisites**

MCEN 1025

MCEN 2024 or equivalent

MCEN 2063 or equivalent

## **Next Course in Sequence**

MCEN 4045 Senior Design

**How this fits into the big picture:** MCEN 3025 places a heavy emphasis on the physics and fundamental engineering behind the mechanical components you will use to build future systems. This course familiarizes students with the best ways to select components such as bearings and threaded fasteners and assemble them in order to develop reliable solutions.

**Example application:** [CeramicSpeed](http://www.ceramicspeed.com) is well known for its work in the bike industry but is also a large supplier of mechanical components for many other applications. Its new hybrid bearings, pictured to the right, increase the strength and durability of production equipment, saving up to 60% of bearing related maintenance costs.

## **Insider insight/things that are good to know in advance:**

In this course, you and your team will have the opportunity to build a drill powered vehicle to race at the end of the semester. This project is very hands on and typically requires a large amount of manufacturing. You can save yourself a lot of time and stress by creating a manufacturing plan and working with the machine shop early on in the project.

**Alternate options to complete:** None



Ball bearing designed for cycling applications by Ceramic Speed

[www.ceramicspeed.com/en/cycling](http://www.ceramicspeed.com/en/cycling)

## **If you enjoy this class, try:**

MCEN 4173: Finite Element Analysis

MCEN 5045: Design for Manufacturability

MCEN 5055: Advanced Product Design

MCEN 5228: Fracture Mechanics





# MCEN 3030: Computational Methods

*Studies fundamental numerical techniques for the solution of commonly encountered engineering problems. Includes methods for linear and nonlinear algebraic equations, data analysis, numerical differentiation and integration, ordinary and partial differential equations.*

## **Prerequisites**

*APPM 2360 or equivalent  
CSCI 1300 or equivalent*

## **Next Course in Sequence**

*MCEN 3047 Data Analysis  
MCEN 4043 System  
Dynamics  
MCEN 4045 Senior Design*

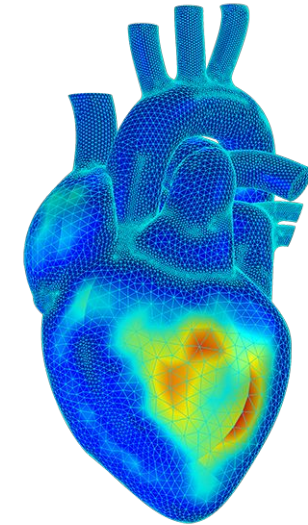
**How this fits into the big picture:** Without the application of computational methods, many of the engineering problems solved in today's world would be very time consuming and difficult to solve beyond simple cases. Utilizing the power of computers, complex systems can be broken down into equations that can be solved in rapid succession to model a dynamic system or find an optimal solution for a problem with many variables and constraints.

**Example application:** [System Insight Engineering](https://siesimulation.com/simulation-3/) leverages the power of computational modeling to deliver industry leading results in fields such as energy-tissue interaction and tissue heating reactions.

## **Insider insight/things that are good to know in advance:**

MCEN 3030 is often heavy on MATLAB based work. If you have not worked with MATLAB much in the past it is important to practice coding in the environment before the class starts or at the beginning of the semester.

**Alternate options to complete:** APPM 4600 or CSCI 3656



Simulation of the human heart displayed on  
System Insight Engineering's homepage  
<https://siesimulation.com/simulation-3/>

## **If you enjoy this class, try:**

MCEN 4125: Optimal Design  
MCEN 4157: Automated Mechanical Design  
MCEN 4155: Modeling of Human Movement  
MCEN 4338: Computational Fluid Dynamics



# MCEN 3032: Thermodynamics 2

*Offers advanced topics and applications for thermal system design and analysis. Topics include thermodynamics of state, entropy, thermodynamic cycles and reacting and nonreacting mixtures. Provides application to power generation, refrigeration and HVAC with conventional and advanced technologies.*

## **Prerequisites**

*MCEN 3021 or equivalent  
MCEN 3012 or equivalent  
APPM 2360 or equivalent*

## **Next Course in Sequence**

*None*

**How this fits into the big picture:** As the name suggest, MCEN 3032 builds off many of the concepts introduced in MCEN 3012 Thermodynamics. Specifically, Thermo 2 focuses on power generation cycles, HVAC, and chemical reactions within processes such as combustion.

**Example application:** [CU Boulder's Utility and Energy Services](#) is responsible for the design, operation, maintenance, and repair of the campus's energy generation and distribution infrastructure for steam (heating), chilled water (cooling), and electricity. Manufacturing and building systems across industries rely on similar groups to design and maintain their heating, cooling and utility systems.

## **Insider insight/things that are good to know in advance:**

A big portion of the class is a design project that you'll work on with a small team. There are a few options to choose from, but each of them provides an opportunity to design a system using the course material. This project provides great context for how engineering solutions can save or cost a company a lot of money.

**Alternate options to complete:** None



*A medium-size steam generation boiler in the East District Energy Plant at CU Boulder*

## **If you enjoy this class, try:**

MCEN 4152: Combustion  
MCEN 4194: Energy Conversion & Storage  
MCEN 4228: Thermofluids Lab  
MCEN 4012: Renewable Fuels, Fuel Cells, and Internal Combustion Engines



# MCEN 3047: Data Analysis and Experimental Methods

*Learn to plan and carry out experiments and analyze the results. Topics covered include measurement fundamentals, design of experiments, elementary statistics and uncertainty analysis. Topics in statistics include probability, error propagation, confidence intervals, hypothesis testing, linear regression, and one- and two-factor ANOVA.*

## **Prerequisites**

APPM 2360 or equivalent  
MCEN 2063 or equivalent  
PHYS 1140 or equivalent

## **Corequisites**

Writing Requirements  
ECEN 3010 or equivalent  
MCEN 3030 or equivalent

## **Next Course in Sequence:**

MCEN 4045 Senior Design

**How this fits into the big picture:** Modeling and theoretical calculations only provide the answer to a problem sometimes. In many scenarios, experiments are needed to discover the behavior of materials, reactions, or systems. Those experiments are a valuable tool in research, development, and testing of new products.

**Example application:** The Laboratory for Atmospheric and Space Physics (LASP) is a research facility on the CU Boulder campus that designs, tests, and sends research instruments into space. They use many kinds of data analysis and experimental methods to ensure that the systems they design are ready for space.

**Insider insight/things that are good to know in advance:** This class includes a combination of statistics and hands-on lab work. You'll learn how to use data acquisition systems, follow test protocols, and analyze the data you collect.

**Alternate options to complete:** GEEN 3853



Solar Radiation and Climate Experiment (SORCE) Satellite in a LASP clean room

[lasp.colorado.edu/home/missions-projects/mission-history-all/](http://lasp.colorado.edu/home/missions-projects/mission-history-all/)





# MCEN 4026: Manufacturing

*Examines manufacturing processes for metals, polymers, and composites as well as manufacturing systems that integrate these processes. Lecture topics include forming, machining, joining, assembling, process integration, computer-aided manufacturing, and manufacturing system engineering.*

## **Prerequisites**

MCEN 2024 or equivalent

## **Next Course in Sequence:**

MCEN 4045 Senior Design

## **How this fits into the big picture:**

How does stuff get made? From raw materials to a finished product, imagine the supply chain, logistics, (statistical) quality control, economics, machines, and people involved at every stage of the process, across the world. Understanding different manufacturing processes and systems enables mechanical designers to make smart choices regarding materials selection, processing methods, and physical features.

**Example application:** [Accu-Precision](#) manufactures custom parts, sheet metal and assemblies for aerospace and industrial applications. They work with customers to provide engineering services and fabricate components using equipment including milling machines, lathes, grinders, punches, and presses.

## **Insider insight/things that are good to know in advance:**

In-person labs (including pouring your own molten Al) and watching YouTube videos about manufacturing are vital and fun parts of the course. Expect to disassemble and analyze everyday objects, and to learn from cool guest speakers too.

**Alternate options to complete:** None



Automated scrap metal disposal system designed by ME students for Accu-Precision  
[www.colorado.edu/mechanical/2022/04/12/mechanical-engineering-students-build-machine-automate-scrap-metal-disposal](http://www.colorado.edu/mechanical/2022/04/12/mechanical-engineering-students-build-machine-automate-scrap-metal-disposal)

## **If you enjoy this class, try:**

MCEN 5045: Design for Manufacturability  
MCEN 4036: Lean/Six Sigma Manufacturing



# MCEN 4043: System Dynamics

*Covers linear dynamic systems and mathematical tools for understanding them, input-output relationships, modeling templates, complex variables, Laplace transform, time-harmonic forcing and response, Fourier series, and multi-domain systems.*

## **Prerequisites**

*APPM 2360 or equivalent  
MCEN 2043 or equivalent  
ECEN 3010 or equivalent*

## **Corequisites**

*MCEN 3030 or equivalent*

## **Next Course in Sequence:**

*MCEN 4045 Senior Design*

**How this fits into the big picture:** System Dynamics is all about putting an input into a system and anticipating what will come out the other side. It allows you to break down complex systems to figure out how they work and how they can be improved. It includes things like the impact of vibrations on a system and introductory control theory.

**Example application:** [Vita Inclinata](#) designs and builds load stabilization systems for helicopter rescues and for cranes used in the construction industry. Their technology uses control systems to sense and automatically adjust for conditions like wind speed and load weights.

**Insider insight/things that are good to know in advance:** This class involves a lot of complex math. It's probably going to be one of the hardest classes you take at CU, but it's worth it! Try to take MCEN 3030 before MCEN 4043 if you can, since they both tend to have a heavy workload.

**Alternate options to complete:** ECEN 3300+4138 (must take both)



Vita Inclinata's load stabilization technology in a rescue simulation  
[www.mgm-compro.com/news/vita-inclinata-life-rescue-system/](http://www.mgm-compro.com/news/vita-inclinata-life-rescue-system/)

## **If you enjoy this class, try:**

MCEN 4125: Optimal Design  
MCEN 4138: Feedback Control  
MCEN 4228: Industrial Automation  
MCEN 4228: Vibrations



# MCEN 4045/4085: Senior Design

*Two-course capstone design experience in mechanical engineering. Covers problem definition, determining design requirements, alternative design concepts, engineering analysis, proof-of-concept prototype and CAD drawings.*

*Students make several oral design reviews, a final design presentation, and prepare a written report.*

## **Prerequisites**

*See flowchart for details*

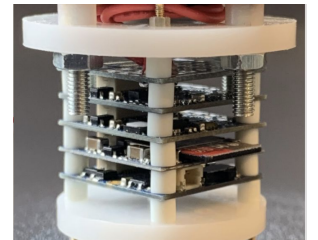
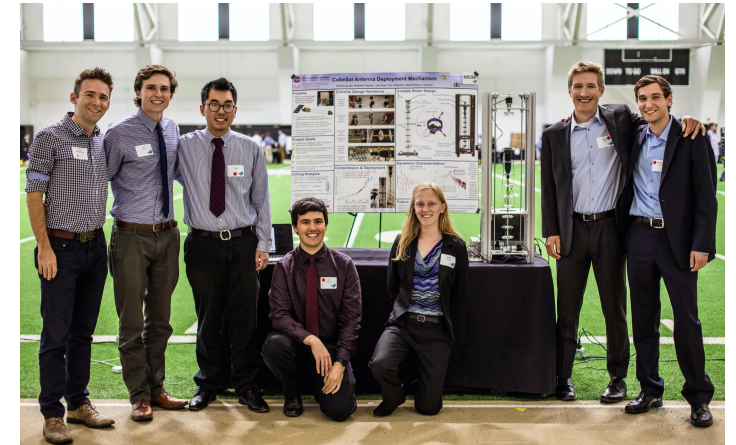
**How this fits into the big picture:** Senior Design is set up to mirror processes and challenges you'll find in industry. You'll work with a team of 5-12 students on a year-long project and will go through the full design, analysis, fabrication, and testing cycle. Each team is assigned a faculty or industry director, who serves as their mentor throughout the year. Project deliverables are expected to be professional quality and will be showcased in a public expo.

**Example application:** You can find examples of past years' projects on the [Senior Design website](#).

## **Insider insight/things that are good to know in advance:**

There are two sections of senior design. Teams in the *Industry* section work on projects sponsored by industry clients or on competition teams. Teams in the *Engineering for Social Innovation* section identify their own project to focus on and participate in the New Venture Challenge. Incoming seniors learn more about those options at the required Pre-Expo in April of their junior year.

**Alternate options to complete:** None



Senior Design teams and projects

[www.colorado.edu/mechanical/senior-design](http://www.colorado.edu/mechanical/senior-design)

