Mechanical Engineering

The Department of Mechanical Engineering offers three graduate degree programs: the Master of Engineering (M.Eng), the Master of Science (M.S.), and the Doctor of Philosophy (Ph.D.).

Master of Engineering (M.Eng)

This accelerated Masters of Engineering Program has been designed in collaboration with several other departments in the College of Engineering for the purpose of developing professional leaders who understand the technical, environmental, economic, and social issues involved in Mechanical Engineering. It is supported by the College of Engineering's Coleman Fung Institute for Engineering Leadership. For more information about this interdisciplinary program, please see the Fung Institute Website (http://funginstitute.berkeley.edu/).

There are full-time and part-time options for pursuing this program.

Master of Science (M.S.)

The MS degree can be earned only in conjunction with a Ph.D. (for the MS/PhD option) as application for the terminal M.S. is currently paused. Degrees are granted after completion of a program of study that emphasizes the application of the natural sciences to the analysis and solution of engineering problems. Advanced courses in engineering, math, and the sciences are normally included in a program that incorporates the engineering systems approach for the analysis of problems.

Doctor of Philosophy (Ph.D.)

This degree can be completed in conjunction with a master of science degree or alone. Degrees are granted after completion of programs of study that emphasize the application of the natural sciences to the analysis and solution of engineering problems. Advanced courses in mathematics, chemistry, physics, and the life sciences are normally included in a program that incorporates the engineering systems approach for the analysis of problems.

Admission to the University

Applying for Graduate Admission

Thank you for considering UC Berkeley for graduate study! UC Berkeley offers more than 120 graduate programs representing the breadth and depth of interdisciplinary scholarship. The Graduate Division hosts a complete list (https://grad.berkeley.edu/admissions/choosing-your-program/list/) of graduate academic programs, departments, degrees offered, and application deadlines can be found on the Graduate Division website.

Prospective students must submit an online application to be considered for admission, in addition to any supplemental materials specific to the program for which they are applying. The online application and steps to take to apply can be found on the Graduate Division website (https://grad.berkeley.edu/admissions/steps-to-apply/).

Admission Requirements

The minimum graduate admission requirements are:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A satisfactory scholastic average, usually a minimum grade-point average (GPA) of 3.0 (B) on a 4.0 scale; and
3. Enough undergraduate training to do graduate work in your chosen field.

For a list of requirements to complete your graduate application, please see the Graduate Division's Admissions Requirements page (https://grad.berkeley.edu/admissions/steps-to-apply/requirements/). It is also important to check with the program or department of interest, as they may have additional requirements specific to their program of study and degree. Department contact information can be found here (https://guide.berkeley.edu/graduate/degree-programs/).

Where to apply?

Visit the Berkeley Graduate Division application page (http://grad.berkeley.edu/admissions/apply/).

Normative Time

5 years or 10 semesters

Minimum Number of Units To Complete Degree

36 Semester units. For students who are in the process of obtaining or have obtained their master's degrees at UC Berkeley, master's degree units that meet the restrictions below can be used towards their PhD unit requirement.

Minimum Units You Required In Order To Be Registered Each Semester

Students must enroll in 15 units each semester

Maximum Amount of Independent Study Units (298, 299, 300 and Above)

Independent course units are not counted towards the 36 semester units needed to graduate. The maximum of these units you can enroll per semester are listed below.

- 298s: 8 units
- 299s: 12 units
- 300s: 6 units
- 600s: 8 units

Maximum Number of Courses That Can Be Transferred Towards Degree

Students can transfer up to 2 courses from another school towards the PhD

- *Courses must be in the major field of study*
- Courses must be letter graded
- Courses cannot be from the student's Undergraduate course of study; courses must have been taken while in graduate standing

GSI/ME 300-Level Course Requirement

Each student must either serve as a Graduate Student Instructor (GSI) for at least 1 semester or have taken a 300-level course on teaching.

Minimum Grade Point Averages (GPAs)

All students are required to have the following minimum Grade Point Averages:

- 3.5 in Major
- 3.0 in Minors

Only courses with a C- or better can count towards graduate requirements. Please note that only 1/3 of your unit total at the time of graduation may be pass/not pass or satisfactory/unsatisfactory. Please note that to earn a “pass” or a “satisfactory” grade in a graduate course you need a grade of B- or better.

Required Emphases

Each student must declare 1 Major area as well as 2 Minors. At least one Minor is required to be outside of the department. The minor fields are required to broaden the base of the studies and lend support to the major field as well as the dissertation research.

Required Number of Courses

- 5 Courses in your major, all of which must be letter graded
- 3 Courses in your First Outside ME Minor (only 1 of these courses can be taken with the Satisfactory/Unsatisfactory option rather than letter graded)
- 2 Courses in your Inside ME or 2nd Outside ME Minor, all of which must be letter graded 2 Courses to support your Major or one Minor

Please note that 2/3 of the courses counted towards your degree must be letter graded.

Preliminary Examination (Prelim)

The objective of the Preliminary Examination is the early assessment of a student's potential for satisfactory completion of the doctoral degree. The exams are entirely closed - no books or notes are allowed. Please see the FAQ (http://www.me.berkeley.edu/graduate/resources/prelim-exams/) on the department website for the latest information.

The examination is given twice a year, during the first week of the Spring and Fall semesters, and must be taken following two semesters of registration as a graduate student at the latest. Tests cannot be taken before entering the program.

Qualifying Examination

This is an oral exam which covers courses and research. Exam should be scheduled 1 month in advance of the end of student’s 3rd year/6th semester. Students receive 2 attempts to pass. It may be taken after having completed:

- 4 courses in the major for a GPA of 3.5, all of which must be letter-graded
- 2 courses in each minor for a GPA of 3.0
- *Or, if you are in the Mechanics major field, all courses need to have been taken.*

Qualifying Exam Committee Requirements

- Chair (the first Inside ME member)
- Second Inside ME member
- Third Inside ME or additional members
- Outside ME member
- At least 2 members must be from the ME Department
- The Chair of the Qualifying Examination
- Committee cannot also serve as the Chair of the Dissertation Committee for the same student
- There cannot be co-chairs for the Qualifying Exam

Detailed requirements can be found in Graduate Division’s *Guide to Graduate Policy*: http://grad.berkeley.edu/policy/

Advancement To Candidacy

All students must complete the Advancement to Candidacy Application directly after passing their qualifying exam. The form can be found Section 13. (http://www.me.berkeley.edu/graduate-student-handbook/chapter-13-forms/)

PhD Dissertation

Dissertations are required of all students. Each dissertation committee must include

All members of the dissertation committee must be members of the Berkeley Division of the Academic Senate. Detailed requirements and restrictions can be found in Graduate Division’s *Guide to Graduate Policy*: http://grad.berkeley.edu/policy/

PhD Candidate Seminar

Each student must present their dissertation findings with at least one member of their dissertation committee present. The seminar must take place prior to the end of the semester in which you receive your degree.

Note: The MS degree can be earned only in conjunction with a Ph.D. (for the MS/PhD option) as application for the terminal M.S. is currently paused temporarily.

Plan I

Generally, this Plan is used by some people who are funded by government projects whose sponsors require them to write a thesis as a component/stipulation of their support. It is not a common option.

Normative Time

1.5 years or 3 semesters

Minimum Number of Units To Complete Degree

20 Semester Units

Course Restriction: Must be either in 200 series or 100 elective upper division series

Minimum Number of Mechanical Engineering Units

8 Semester Units

Course Restriction: Must be in 200 series and letter-graded

Minimum Units Required to Be Registered Each Semester

Students must enroll in 15 units each semester

Maximum Amount of Independent Study Units (298, 299, 300 And Above)

The maximum units in which you can enroll per semester are listed below.

- 298s: 8 units
- 299s: 12 units*
- 300s: 6 units

*Please note that only 4 units of 299 can be counted towards the 20 unit total requirement.

Residency, Minimum GPA, and P/NP & S/U

To be eligible to receive the Master's degree, the student must complete at least two semesters in residency and undertake the total coursework units defined for the program, earning a CGPA of at least 3.0. Only courses with a C- or better can count towards graduate requirements.

Please note that only 1/3 of your unit total at the time of graduation may be pass/not pass or satisfactory/unsatisfactory. Please note that to earn a "pass" or a "satisfactory" grade in a graduate course you need a grade of B- or better.

Minimum Recommended Number of Units in Major Field Area (E.g. Bioeng, Controls, Etc.)

8 Semester units from 200 or 100 upper division series

Maximum Number of Units You Can Transfer Towards Your Masters Degree

A master's student may transfer up to 4 semester units or 6 quarter units of course work completed as a graduate student at another institution. The units must be equivalent to courses in the student's graduate program at Berkeley, and the student must have received at least a B in the course(s) and have a grade-point average of at least 3.3 at both Berkeley and the other institution. However, students cannot use units from another institution to satisfy the minimum unit requirement in 200 series courses or the minimum academic residence requirement. In addition, they may not present course work previously used to satisfy requirements for another degree program at Berkeley or at another institution.

Berkeley undergraduates who take graduate course work during their last undergraduate semester may petition to backdate graduate standing in order to receive graduate credit for that course work. Graduate standing may be backdated from the last semester, and students may petition for credit only for the course work that was not required for the undergraduate degree.

All petitions to have units transferred must be first approved by the Vice-Chair for Graduate Study. The ViceChair then forwards the petitions to Graduate Division.

Detailed restrictions can be found in Graduate Division's Guide to Graduate Policy (http://grad.berkeley.edu/policies/guides/category/ggp/). (http://grad.berkeley.edu/policies/guides/category/ggp/)

Advancement to Candidacy

Before you can receive a Master's degree, you must first be *Advanced to Candidacy*. The opportunity for this occurs during the first four (4) weeks of each semester. By Academic Senate regulation, a minimum period of study of one term must intervene between formal advancement to candidacy and the conferring of the master's degree. The form can be found on in Chapter 13 (http://www.me.berkeley.edu/graduate-student-handbook/chapter-13-forms/). (http://www.me.berkeley.edu/graduate-student-handbook/chapter-13-forms/)

Thesis

Thesis Committee

Three (3) committee members are needed for the thesis (please see restrictions below). All committee members are required to be members of the Berkeley Division of the Academic Senate. - Your Research Adviser

- ME Professor
- Professor outside of the ME Department
- At least two committee members must be from ME
- All members must also be members of the Berkeley Division of the Academic Senate

Procedures for Filing Your Thesis

After you have written your thesis, formatted it correctly, assembled the pages into the correct organization, and obtained your signatures, you are ready to file it with the UC Berkeley's Graduate Division:

- Convert your thesis to a standard PDF file.
- Print and sign the Thesis Release Form (http://grad.berkeley.edu/policies/pdf/masters_release.pdf). (http://grad.berkeley.edu/policies/pdf/masters_release.pdf)
- Email your thesis as an attachment to edegrees@berkeley.edu. Put your full name in the subject line. Note: DO NOT SUBMIT A DRAFT. Once your thesis has been submitted, you will not be allowed to make changes. Be sure that it is in its final form!
- The Degrees Office staff will review your submission and if everything is in order, you will receive an email stating that it has been approved. If you need to make changes, you will be given the opportunity and will need to re-send a revised PDF.
- Submit the following final documents to the Graduate Degrees Office at 318 Sproul Hall: your signed approval page, and your signed Thesis Release Form (http://grad.berkeley.edu/policies/pdf/masters_release.pdf). (http://grad.berkeley.edu/policies/pdf/masters_release.pdf)
- Submit a copy of the final documents to the Student Services Office at 6189 Etcheverry Hall.

Please note that all documents should be submitted together (the Graduate Degrees Office will not accept lone signature pages, for example). You must submit your electronic thesis and bring your final documents to 318 Sproul Hall before 4:00 P.M. on the last day of the term.

For details about filing requirements, including information on deadlines, preparing the thesis, registration, and use of human or animal subjects, please see Instructions for Preparing and Filing Your Thesis (http://grad.berkeley.edu/policies/guides/thesis-filing/) and Policies Affecting Both Master's and Doctoral (http://grad.berkeley.edu/policy/fullguide/#f4-policies-affecting-both-masters-and-doctoral-students)Students (http://grad.berkeley.edu/policy/fullguide/#f4-policies-affecting-both-masters-and-doctoral-students). (http://grad.berkeley.edu/policy/fullguide/#f4-policies-affecting-both-masters-and-doctoral-students)

Changes in Committee Membership

Before planning to file their theses, students who wish to change the membership of their thesis committee must be sure that such a change has been approved by the Graduate Division. A student may request a change in committee by submitting a completed Change in Higher Degree Committee form. The Head Graduate Adviser (who is our Vice Chair of Graduate Study) must state the reason for the change and sign the form. The Head Graduate Adviser, rather than any committee member, has the final authority to approve the changes. Forms are available from the Graduate Division website (http://www.grad.berkeley.edu/policies/forms.shtml/). (http://www.grad.berkeley.edu/policies/forms.shtml/)

Library Permission Form

Each student filing a master's thesis must also submit a completed Library Permission Form (http://grad.berkeley.edu/policies/pdf/masters_release.pdf), (http://grad.berkeley.edu/policies/pdf/masters_release.pdf) stating whether or not the student is willing to allow the University Library to supply copies of the thesis to any interested persons immediately, or if permission to do so should be withheld (for up to two years) while the student applies to obtain copyright.

Plan II

This Plan is the common master's degree plan in our department; very rarely do students choose to complete Plan I. The primary differences between Plan II and Plan I is Plan II requires 24 units (see below for details) and an Oral Presentation and Report, while Plan I requires 20 units and a Thesis

Normative Time

1.5 years or 3 semesters

Minimum Number of Units To Complete Degree

24 Semester Units

Course Restriction: Must be either in 200 series or 100 elective upper division series. At most, one third of the total units of course work may be taken S/U

Minimum Number of Mechanical Engineering Units

12 Semester Units

Course Restriction: Must be in 200 series and letter-graded with the exception of the optional 4 units of ME 299 that can be included in the 12

Minimum Units to Be Registered Each Semester

Students must enroll in 15 units each semester.

Maximum Amount of Independent Study Units (298, 299, 300 And Above)

The maximum units in which you can enroll per semester are listed below.

- 298s: 8 units
- 299s: 12 units*
- 300s: 6 units

*Please note that only 4 units of 299 can be counted towards the 24 unit total requirement.

Minimum Required Number of Units in Major Field Area (ex. Bioeng, Controls, Etc.)

12 Semester units

Course Restriction: Must be in 200 or 100 elective upper division series

Residency, Minimum GPA, and P/NP & S/U

To be eligible to receive the Master's degree, the student must complete at least two semesters in residency and undertake the total coursework units defined for the program, earning a CGPA of at least 3.0. Only courses with a C- or better can count towards graduate requirements.

Please note that only 1/3 of your unit total at the time of graduation may be pass/not pass or satisfactory/unsatisfactory. Please note that to earn a "pass" or a "satisfactory" grade in a graduate course you need a grade of B- or better.

Maximum Number of Units You Can Transfer Towards Your Master's Degree

A master's student may transfer up to 4 semester units or 6 quarter units of course work completed as a graduate student at another institution. The units must be equivalent to courses in the student's graduate program at Berkeley, and the student must have received at least a B in the course(s) and have a grade-point average of at least 3.3 at both Berkeley and the other institution. However, students cannot use units from another institution to satisfy the minimum unit requirement in 200 series courses or the minimum academic residence requirement. In addition, they may not present course work previously used to satisfy requirements for another degree program at Berkeley or at another institution.

Berkeley undergraduates who take graduate course work during their last undergraduate semester may petition to backdate graduate standing in order to receive graduate credit for that course work. Graduate standing may be backdated from the last semester, and students may petition for credit only for the course work that was not required for the undergraduate degree.

All petitions to have units transferred must be first approved by the Vice-Chair for Graduate Study, then forwarded to Graduate Division. Detailed restrictions can be found in Graduate Division's Guide to Graduate (http://grad.berkeley.edu/policy/fullguide/) Policy. (http://grad.berkeley.edu/policy/fullguide/)

Advancement to Candidacy

Before you can receive a Master's degree, you must first be Advanced to Candidacy. The opportunity for this occurs during the first four (4) weeks of each semester. By Academic Senate regulation, a minimum period of study of one term must intervene between formal advancement to candidacy and the conferring of the master's degree.

Please complete the Application for Candidacy for Master's Degree Form (https://me.berkeley.edu/wp-content/uploads/2019/01/Candidacy_MS_Plan2.pdf) and bring it to 6189 Etcheverry Hall for processing.

Filing Your Master's Report (Plan II)

After you have written your report, formatted it correctly, assembled the pages into the correct organization, and obtained your signatures, you are ready to file your report (Plan II). The steps are as follows:

1. Convert your report to a standard PDF file.
2. Complete, sign, and convert the Library Permission Form (http://www.me.berkeley.edu/sites/default/files/graduate/Library%20Permission%20-%20New.pdf) to a standard PDF file. Each student filing a master's report must also submit a completed library permission form, stating whether or not the student is willing to allow the University Library to supply copies of the report to any interested

persons immediately, or if permission to do so should be withheld (for up to two years) while the student applies to obtain copyright.

3. Log on your account on the College of Engineering Student Progress Summary Database (https://willow.coe.berkeley.edu/PHP/gradstud/menu.php) w (https://willow.coe.berkeley.edu/PHP/gradstud/menu.php)ebpage.
4. Under "Document Type", select "Library Permission".
5. Under "Upload File", click on "Choose file" to browse and navigate through your computer to locate and select your signed library permission form. You should see your file name displayed near the menu "Choose File".
6. Click on "submit" at the bottom of your summary page. Once your file is successfully uploaded, you will see it on the page.
7. Repeat the same procedure to upload your Master's Report.

Note: DO NOT SUBMIT A DRAFT. Once your report has been submitted, you will not be allowed to make changes. Be sure that it is in its final form and the cover-page is signed by the committee members!

Please note that all documents should be submitted together (e.g. signed Report and the signed Library Permission Form). The Graduate Student Services Office will not accept lone signature pages. You must submit your electronic report before 4:00 P.M. on the indicated deadline date listed on the Graduate Division's website.

Oral Presentation and Final Report (Plan II)

An oral presentation and a written report are required. 2 Faculty are required to be present. At least one needs to be from the MS Committee. All committee members are required to be members of the Berkeley Division of the Academic Senate.

Degree Committee Members

Two committee members are needed for the report:

- Your Research Advisor
- ME Professor or Professor outside the ME department
- At least one committee members must be from ME
- Both members must also be members of the Berkeley Division of the Academic Senate

Normative Time

Full-time: Nine months or two semesters.

Part-time: Two-four years, depending on the student. Part-time students take the same classes as full-time students.

Minimum Number of Units to Complete Degree

25 semester units

Course restriction: must be in 200 series.

Minimum Number of Mechanical Engineering Units in Area of Concentration

12 semester units (must be in 200 series and letter-graded). Only courses with a C- or better can count towards graduate requirements.

Minimum Grade Point Averages (GPAs)

All students are required to have a minimum overall grade point average of 3.0.

Minimum Units You Are Required to Take in Order to Be Registered Each Semester

Full-time graduate students must enroll in 12 Semester units each semester. Part-time students may take one-to-three courses per semester and complete the program at their own pace in 2-4 years*

*Students must enroll in a minimum 6 units per semester to be eligible for financial aid, including federal loans

Maximum Number of Units Transferable Towards Master's of Engineering Degree

A master of engineering student may petition to transfer up to four semester units or six quarter units of 200-level courses completed as a graduate student at another UC campus.

Advancement To Candidacy

Students should apply for advancement to candidacy at the beginning of their second semester.

Comprehensive Leadership and Technical Exam

A student must pass a comprehensive leadership exam and a comprehensive technical exam to receive their MEng degree..

Curriculum

Courses Required

Approved individualized study list per student's interest in concentration area, including the courses below:		
ENGIN 270A	Organizational Behavior for Engineers	1
ENGIN 270B	R&D Technology Management & Ethics	1
ENGIN 270C	Teaming & Project Management	1
ENGIN 270H	Accounting & Finance for Engineers	1
ENGIN 296MA	Master of Engineering Capstone Project	3
ENGIN 296MB	Master of Engineering Capstone Project	2
ENGIN 295	Communications for Engineering Leaders (1 unit in fall and 1 unit in spring)	1
Choose ENGIN 270D or ENGIN 270E		
ENGIN 270D	Entrepreneurship for Engineers	1
ENGIN 270E	Technology Strategy & Industry Analysis	1
Choose ENGIN 270F or ENGIN 270G		
ENGIN 270F	Data Analytics	1
ENGIN 270G	Marketing & Product Management	1

Concentrations

Advanced Energy Technology

Provides you with both technical and business foundations in energy engineering sciences and their potential applications in leading edge technologies, in fields such as advanced combustion, nanoscale energy conversion, and large scale renewable energy systems.

Coursework offerings vary year by year, and may include:		
MEC ENG 235	Design of Microprocessor-Based Mechanical Systems	4
MEC ENG 246	Advanced Energy Conversion Principles	3
MEC ENG 249	Machine Learning Tools for Modeling Energy Transport and Conversion Processes	3
MEC ENG 250B	Advanced Convective Transport and Computational Methods	3

MEC ENG 254	Advanced Thermophysics for Applications	3
MEC ENG 255	Advanced Combustion Processes	3
MEC ENG 258	Heat Transfer with Phase Change	3
MEC ENG 259	Microscale Thermophysics and Heat Transfer	3

Aerospace Engineering (NEW)

Aerospace Engineering has seen exponential growth over the last decade spanning: Commercial Aircraft, Urban Air Mobility, Spacecrafts, Military Aircraft, Drones, Satellites, Telecommunications, and Supersonic flight. This track provides you with both technical and business foundations in Aerospace Engineering and their potential applications in leading edge technologies.

Required courses:		
Mechanical Engineering course in Aerodynamics (MEC ENG 200+)		
MEC ENG 236U	Dynamics and Control of Autonomous Flight	3
Students must take at least two courses from the following list. Coursework offerings may vary year to year.		
Highly recommended:		
MEC ENG 227	Mechanical Behavior of Composite Materials [3]	
MEC ENG C231A	Experiential Advanced Control Design I [3]	
MEC ENG C23	Experiential Advanced Control Design II [3]	
MEC ENG 245	Oceanic and Atmospheric Waves [3]	
MEC ENG 255	Advanced Combustion Processes [3]	
MEC ENG 260A	Advanced Fluid Mechanics I [3]	
MEC ENG 260I	Advanced Fluid Mechanics II [3]	
MEC ENG 262	Hydrodynamic Stability and Instability [3]	
MEC ENG 280A	Introduction to the Finite Element Method [3]	
MEC ENG 285A	Foundations of the Theory of Continuous Media [3]	
MEC ENG 263	Turbulence [3]	
MEC ENG 266	Geophysical and Astrophysical Fluid Dynamics [3]	
MEC ENG 275	Advanced Dynamics [3]	
MEC ENG 287	Graduate Introduction to Continuum Mechanics [3]	
Optional:		
MEC ENG 273	Oscillations in Linear Systems [3]	
MEC ENG 277	Nonlinear and Random Vibrations [3]	
MEC ENG 280B	Finite Element Methods in Nonlinear Continua [3]	
MEC ENG 282	Theory of Elasticity [3]	
MEC ENG 284	Nonlinear Theory of Elasticity [3]	
MEC ENG 289	Theory of Shells [3]	
ENGIN 266A	Finite Difference Methods for Fluid Dynamics [4]	
ENGIN 266B	Spectral Methods for Fluid Dynamics [4]	

Biomechanics

The Masters of Engineering (MEng) track in Biomechanical Engineering covers theories, methods, and practice of biomechanical engineering. Students will gain skills through biomechanics-focused courses, as well as through advanced courses in mechanics, materials, manufacturing and design. Courses will enable students to work on cutting-edge biomechanical engineering grand challenges. Capstone projects bring biomechanical prowess to ongoing clinical needs. Students will also gain skills in verbal and oral communication and mentorship. Biomechanical students are expected to take four technical courses from the list below as well as a capstone experience course.

Coursework offerings vary year by year, and may include:		
MEC ENG C210	Advanced Orthopedic Biomechanics	4
MEC ENG 211	The Cell as a Machine	3
MEC ENG C213	Fluid Mechanics of Biological Systems	3
MEC ENG C214	Advanced Tissue Mechanics	3
MEC ENG C215	Advanced Structural Aspects of Biomaterials	4
MEC ENG C216	Molecular Biomechanics and Mechanobiology of the Cell	4
MEC ENG C223	Polymer Engineering	3
MEC ENG C225	Deformation and Fracture of Engineering Materials	4
MEC ENG 239	Robotic Locomotion	4
MEC ENG 270	Advanced Augmentation of Human Dexterity	4
MEC ENG C278	Adv Designing for the Human Body	4
MEC ENG 290L	Introduction to Nano-Biology	3
MEC ENG 292A	Advanced Special Topics in Bioengineering	1-4
MEC ENG 292C	Advanced Special Topics in Design	1-4

Control of Robotic and Autonomous Systems

*(*Formerly *Experimental Advanced Control Systems Design)*

The complexity of modern robotic and autonomous systems has grown exponentially in the past ten years. Today's engineers are challenged by the task of building high-performance machines which: (1) are safe despite the uncertainty of the environment they operate in; (2) are able to interact with humans; and (3) effectively use data, local embedded control platforms and distributed cloud computing. You will gain experience in state-of-the-art control systems design and implementation for such modern and highly complex systems. This concentration immerses you in the design and application of advanced controls systems, with numerous cutting-edge applications such as self-driving cars, drones, aerospace systems, and robotics for manufacturing and human assistance.

Coursework offerings vary year by year, and may include:		
MEC ENG C231A	Experiential Advanced Control Design I	3
MEC ENG C231B	Experiential Advanced Control Design II	3
MEC ENG C232	Advanced Control Systems I	3
MEC ENG 233	Advanced Control Systems II	3
MEC ENG 235	Design of Microprocessor-Based Mechanical Systems	4
MEC ENG 237	Control of Nonlinear Dynamic Systems	3
MEC ENG 292B	Advanced Special Topics in Controls (Control and Dynamics of Unmanned Aerial Vehicles)	1-4
MEC ENG 292C	Advanced Special Topics in Design (Feedback Control of Legged Robots)	1-4

Fluids and Ocean (NEW)

This track provides graduates with a firm foundation in analytical, computational, and experimental essentials of fluid dynamics. Research activities span the Reynolds number range from creeping flows to planetary phenomena. Topics of current study include suspension mechanics, dynamics of phase changes (in engineering and in geophysical flows), earth mantle dynamics, interfacial phenomena, non-Newtonian fluid mechanics, biofluid mechanics, vascular flows, chaotic mixing and transport of scalars, bubble dynamics, environmental fluid dynamics, aerodynamics, vortex dynamics and breakdown, aircraft wake vortices, rotating flows, stability and transition, chaos, turbulence, shock dynamics, sonoluminescence, sonochemistry, reacting flows, planetary atmospheres, ship waves, internal waves, and nonlinear wave-vorticity interaction. One key application area is Ocean Engineering, which involves the development, design, and analysis of man-made systems that can operate in the offshore or coastal environment. Such systems may be used for transportation, recreation, fisheries, extraction of petroleum or other minerals, and recovery of thermal or wave energy, among others. Some systems are bottom-mounted, particularly those in shallower depths; others are mobile, as in the case of ships, submersibles, or floating drill rigs. All systems should be designed to withstand a hostile environment (wind, waves, currents, ice) and to operate efficiently while staying environmentally friendly.

Coursework offerings vary year by year, and may include:

Coursework offerings vary year by year, and may include:

MEC ENG 163	Engineering Aerodynamics	3
MEC ENG 165/242	Ocean-Environment Mechanics	3
MEC ENG 167	Microscale Fluid Mechanics	3
MEC ENG 168/292K	Mechanics of Offshore Systems	3
MEC ENG C213	Fluid Mechanics of Biological Systems	3
MEC ENG 241A	Marine Hydrodynamics I	3
MEC ENG 241B	Marine Hydrodynamics II	3
MEC ENG 245	Oceanic and Atmospheric Waves	3
MEC ENG 260A	Advanced Fluid Mechanics I	3
MEC ENG 260B	Advanced Fluid Mechanics II	3
MEC ENG 262	Hydrodynamic Stability and Instability	3
MEC ENG 263	Turbulence	3
MEC ENG 266	Geophysical and Astrophysical Fluid Dynamics	3
MEC ENG C268	Physicochemical Hydrodynamics	3
MEC ENG 290C	Topics in Fluid Mechanics	3
MEC ENG 292K	Advanced Special Topics in Ocean Engineering	1-4
ENGIN 266A	Finite Difference Methods for Fluid Dynamics	4
ENGIN 266B	Spectral Methods for Fluid Dynamics	4

MEMS/Nano *(Micro-Electromechanical Systems/ Nanotechnology)*(NEW)

Over the past 20 years, the application of microelectronic technology to the fabrication of mechanical devices has revolutionized research in microsensors and microactuators. Micromachining technologies take advantage of batch processing to address the manufacturing and performance requirements of the sensor industry. This track provides you with highly interdisciplinary skills in microfabrication, MEMS design, and related topics such as microscale thermophysics, micro and nanoscale tribology, cellular and sub-cellular level transport phenomena and mechanics, and physicochemical hydrodynamics of ultra-thin fluid films.

Coursework offerings vary year by year, and may include:

MEC ENG C218/ EL ENG 247A	Introduction to MEMS Design	4
MEC ENG C231A	Experiential Advanced Control Design I	3
MEC ENG C231B	Experiential Advanced Control Design II	3
MEC ENG 235	Design of Microprocessor-Based Mechanical Systems	4
MEC ENG 238	Advanced Micro/Nano Mechanical Systems Laboratory	3
MEC ENG 259	Microscale Thermophysics and Heat Transfer	3
MEC ENG 280A	Introduction to the Finite Element Method	3
MEC ENG 290L	Introduction to Nano-Biology	3
MEC ENG 290T	Plasmonic Materials	3

Mechanics and Dynamics (NEW)

Having its roots in the classical theory of elastic materials, solid mechanics has grown to embrace all aspects involving the behavior of deformable bodies under loads. Thus, in addition to including the theory of linear elasticity, with its applications to structural materials, solid mechanics also incorporates modern nonlinear theories of highly deformable materials. This includes synthetic polymeric materials, as well as biological materials. Our program also includes other aspects of continuum mechanics including approximate theories (such as those involving moderate strains or moderate rotations) and the Lagrangian representation of vorticity. The behavior of continua that are almost rigid, with a view to characterizing their dynamical characteristics, is also an important top.

Coursework offerings vary year to year, and may include:

MEC ENG 273	Oscillations in Linear Systems	3
MEC ENG 274	Random Oscillations of Mechanical Systems	3
MEC ENG 275	Advanced Dynamics	3
MEC ENG 277	Nonlinear and Random Vibrations	3
MEC ENG C279/ CIV ENG C235	Introduction to Statistical Mechanics for Engineers	3
MEC ENG 280A	Introduction to the Finite Element Method	3
MEC ENG 280B	Finite Element Methods in Nonlinear Continua	3
MEC ENG 281	Methods of Tensor Calculus and Differential Geometry	3
MEC ENG 282	Theory of Elasticity	3
MEC ENG 283	Wave Propagation in Elastic Media	3
MEC ENG 284	Nonlinear Theory of Elasticity	3
MEC ENG 285A	Foundations of the Theory of Continuous Media	3
MEC ENG 285B	Surfaces of Discontinuity and Inhomogeneities in Deformable Continua	3
MEC ENG 285C	Electrodynamics of Continuous Media	3
MEC ENG 285D	Engineering Rheology	3
MEC ENG 286	Theory of Plasticity	3
MEC ENG 287	Graduate Introduction to Continuum Mechanics	3
MEC ENG 288	Theory of Elastic Stability	3
MEC ENG 289	Theory of Shells	3
MEC ENG 290A	Course Not Available	

Modeling and Simulation OF ADVANCED MANUFACTURING PROCESSES

Modern manufacturing can be characterized by three basic processing strategies – additive, subtractive and near-net shape. These are somewhat self-explanatory in their names. Near-net shape, aka forming/ forging and molding techniques. Subtractive, for example, machining, is the “old standby” process used extensively in basic machine construction but is quite limited as applied to higher technology products. Additive manufacturing, ranging from deposition processes to the more recent rapid prototyping approaches, is an area that offers much future potential for both accurate and fast creation of complex products. Additive manufacturing (AM) and Rapid-Prototyping (RP) have received a great deal of attention for a number of years. In particular, the idea of 3-D Printing (3DP) has received quite a large amount of press. According to ASTM, AM is defined as the “process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies. This track provides you with the sophisticated mathematical modeling skills critical to the manufacturing of advanced devices and systems across all sectors and industries. You will gain experience creating the tools that are used in an array of technologies that employ advanced manufacturing and 3D printing.

Coursework offerings vary year to year, and may include:

MEC ENG C201	Modeling and Simulation of Advanced Manufacturing Processes	3
MEC ENG C219	Parametric and Optimal Design of MEMS	3
MEC ENG 221	Graduate Introduction to Lean Manufacturing Systems	3
MEC ENG C223	Polymer Engineering	3
MEC ENG 224	Mechanical Behavior of Engineering Materials	3
MEC ENG C225	Deformation and Fracture of Engineering Materials	4
MEC ENG 226	Tribology	3
MEC ENG 227	Mechanical Behavior of Composite Materials	3
MEC ENG 229	Design of Basic Electro-Mechanical Devices	3
MEC ENG C231A	Experiential Advanced Control Design I	3
MEC ENG 280A	Introduction to the Finite Element Method	3
MEC ENG 280B	Finite Element Methods in Nonlinear Continua	3
MEC ENG 290D	Solid Modeling and CAD/CAM Fundamentals	3
MEC ENG 290G	Laser Processing and Diagnostics	3
MEC ENG 290H	Green Product Development: Design for Sustainability	3
MEC ENG 290I	Sustainable Manufacturing	3
MEC ENG 290R	Topics in Manufacturing	3

Product Design

Theories, methods, and practice of design. Enables you to create, design, develop, and market new and innovative products to meet the needs of consumers from all backgrounds and requirements, including sustainability. You gain skills in communicating with and assessing the needs of the user/customer, prototyping and evaluating potential designs with respect to the performance specifications and requirements and ensuring safe operation, economical production, and reduced energy and resource consumption as well as environmental impact.

Coursework offerings vary year by year, and may include:

MEC ENG C205	Critical Making	4
MEC ENG C223	Polymer Engineering	3
MEC ENG 229	Design of Basic Electro-Mechanical Devices	3
MEC ENG C231A	Experiential Advanced Control Design I	3
MEC ENG 235	Design of Microprocessor-Based Mechanical Systems	4
MEC ENG 290KA	Innovation through Design Thinking	2
MEC ENG 290KB	Life Cycle Thinking in Engineering Design	1
MEC ENG 290D	Solid Modeling and CAD/CAM Fundamentals	3
MEC ENG 290P	New Product Development: Design Theory and Methods	3
MEC ENG 290U	Interactive Device Design	4
MEC ENG 292C	Advanced Special Topics in Design	1-4

Mechanical Engineering

MEC ENG C200 Design, Evaluate, and Scale Development Technologies 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023, Fall 2022, Fall 2021, Fall 2020

This required course for the Designated Emphasis in Development Engineering will include projects and case studies, many related to projects at UC Berkeley, such as those associated with the Development Impact Labs (DIL). Student teams will work with preliminary data to define the problem. They will then collect and analyze interview and survey data from potential users and begin to design a solution. Students will explore how to use novel monitoring technologies and “big data” for product improvement and evaluation. The student teams will use the case studies (with improvements based on user feedback and data analysis) to develop a plan for scaling and evaluation with a rigorous controlled trial.

Objectives & Outcomes

Course Objectives: Students will use multiple qualitative and quantitative methods to learn about user needs, to come up with new concepts and solutions, and to understand how new products and services achieve or fail to achieve their goals in a development setting.

Student Learning Outcomes: Students will be able to apply the skills to current challenges in development engineering
Students will develop a set of skills that will allow them to flourish in a climate of complex problem solving and design challenges in development engineering
Students will learn how to learn from users using qualitative and quantitative tools including surveys, interviews, new monitoring technologies, statistical analyses and experimental designs
Students will learn to participate in and lead innovation and creativity in collaborative settings

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Agogino, Levine

Also listed as: DEV ENG C200

MEC ENG C201 Modeling and Simulation of Advanced Manufacturing Processes 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024, Spring 2024
This course provides the student with a modern introduction to the basic industrial practices, modeling techniques, theoretical background, and computational methods to treat classical and cutting edge manufacturing processes in a coherent and self-consistent manner.
Objectives & Outcomes

Course Objectives: An introduction to modeling and simulation of modern manufacturing processes.

Rules & Requirements

Prerequisites: An undergraduate course in strength of materials or 122

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Zohdi

Also listed as: MAT SCI C286/NUC ENG C226

MEC ENG C202 Computational Design of Multifunctional/Multiphysical Composite Materials 3 Units

Terms offered: Spring 2012
The course is self-contained and is designed in an interdisciplinary manner for graduate students in engineering, materials science, physics, and applied mathematics who are interested in methods to accelerate the laboratory analysis and design of new materials. Examples draw primarily from various mechanical, thermal, diffusive, and electromagnetic applications.
Rules & Requirements

Prerequisites: An undergraduate degree in the applied sciences or engineering

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Zohdi

Also listed as: MAT SCI C287

MEC ENG 203 Nanoscale Processing of Materials 3 Units

Terms offered: Fall 2019
This course surveys sub-micrometer pattern-transfer techniques and methods for handling materials with one or more sub-micrometer dimensions. The optical and mechanical principles underlying a spectrum of candidate lithography techniques are introduced, and extensive examples of industrial applications are discussed. Class material also covers techniques for assembling structures from zero-, one- and two-dimensional materials including nanoparticles, nanotubes, nanowires, and single- and few-atomic-layer sheets of van der Waals solids such as graphene and molybdenite.
Objectives & Outcomes

Course Objectives: The objectives of the course are to:

- Make students aware of current capabilities and innovations in sub-micrometer lithography and in the handling of nanoscale materials;
- Equip students to select an appropriate lithography or processing technique for a given application from among multiple alternatives;
- Provide students with an understanding of the transformations of material that occur in sub-micrometer lithography techniques, such that they can understand why certain processing routes might be preferable to others for particular applications.

Student Learning Outcomes:
- Articulate the key requirements (i.e. resolution, maximum defect density, and multi-layer alignment precision) of micro- and nano-patterning processes to be used in a range of applications, such as semiconductors, hard disk-drives, large-area photovoltaics, and biomedical microdevices.
- Identify which of a set of available micro-/nano-patterning processes (e.g. extreme-UV lithography, directed self-assembly, multiple e-beam lithography, and imprint lithography) are suitable for a given patterning application.
- Accurately explain and distinguish between the physical transformations of material that occur in a number of sub-micrometer patterning processes, including imprint lithography, micro-contact printing, micro-embossing, and micro-gravure.
- Identify a number of currently open research questions relating to nanoscale processing of materials and suggest possible creative solutions to them.
- Use numerical simulation techniques to model the behavior of one or more lithographic techniques, including nanoimprint, photolithography, or electron-beam lithography. Use insights from modeling to optimize key process parameters and to make trade-offs in the geometrical design of a pattern that is to be fabricated.

Rules & Requirements

Prerequisites: An understanding of solid mechanics and statics, or permission of instructor. Experience programming in Matlab is desirable for simulation assignments

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

MEC ENG 204 Advanced Manufacturing Systems Analysis, AMS 3 Units

Terms offered: Spring 2017, Spring 2016, Spring 2015
This course is designed to prepare students for technical leadership in industry. The objective is to provide insight and understanding on the main concepts and practices involved in analyzing, managing systems to deliver high quality, cost effectiveness and sustainable advantages.
The impact of this class on the Mechanical Engineering program includes delivering core production concepts and advanced skills that blend vision and advanced manufacturing elements. This course is highly recommended for students on the Product Design track in Mechanical Engineering's Master of Engineering program.
Objectives & Outcomes

Course Objectives: The objective of this course is to ensure that our students:
a.
Gain solid foundations on the analysis of Advanced Manufacturing Systems Analysis (AMS), including flow analysis concepts, frameworks and methodologies.
b.
Understand and apply sustainable engineering practices.
c.
Put into practice decision-making activities based on solid academic rigor, quantitative tools and simulation models oriented for AMS
d.
Align their AMS to a company's strategy to deliver business advantage.

Rules & Requirements

Prerequisites: This course is open to graduate students, with priority given to students in Mechanical Engineering's Master of Engineering program

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG C205 Critical Making 4 Units

Terms offered: Spring 2025, Spring 2022, Spring 2021, Spring 2020, Spring 2019, Spring 2018
Critical Making will operationalize and critique the practice of "making" through both foundational literature and hands on studio culture. As hybrid practitioners, students will develop fluency in readily collaging and incorporating a variety of physical materials and protocols into their practice. Students will envision and create future computational experiences that critically explore social and culturally relevant technological themes. No previous technical knowledge is required to take this course. Class projects involve basic programming, electronic circuitry, and digital fabrication design. Tutorials and instruction will be provided, but students will be expected to develop basic skills in these areas to complete course projects.
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 2 hours of studio per week

Summer:
6 weeks - 4 hours of lecture and 8 hours of studio per week
8 weeks - 4 hours of lecture and 4 hours of studio per week
10 weeks - 3 hours of lecture and 3 hours of studio per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Formerly known as: New Media 203

Also listed as: NWMEDIA C203

MEC ENG 206 Engineering Design and Prototyping: Pedagogy & Assessment 3 Units

Terms offered: Prior to 2007
This course explores contemporary research in engineering design and prototyping, as well as related cognitive issues in engineering curricular development, pedagogy, and assessment. One recurring theme throughout the course will be the duality between learning and design: design-based research, design as a pedagogy for integrative learning and the role of cognition and the learning sciences in the practice of engineering design. It has been motivated by several reforms: (1) National efforts to better train and educate engineers for the engineering workplace in the 21st Century: to better prepare engineers to face multidisciplinary problems and product design in competitive industries and improve their skills in teamwork and communication.

Objectives & Outcomes

Course Objectives: This course has been developed to bridge student's previous knowledge of disciplinary research in design and prototyping with engineering education research.

- Provide learners the opportunity to question (usually tacit) assumptions about what engineering is, what the purpose and process of engineering education is, and who gets to be an engineer.
- Understand design as a pedagogy for integrative learning and the role of cognition and the learning sciences in the practice of engineering design and prototyping.
- Provide the participants with an understanding of theories and practices in content, assessment, and pedagogy for teaching engineering design and prototyping.
- Familiarize learners with quantitative and qualitative methodologies for data analysis associated with the assessment of design and prototyping interventions.
- Promote critical thinking and a social construction of knowledge by having face-to-face and online discussions of readings from a variety of sources.

Student Learning Outcomes: Students will be able to:

- Identify their own role in shaping engineering and engineering education, and explore paths of connecting their research in Mechanical Engineering (or a related field) educational interests in design and prototyping;
- Think critically, reflectively and holistically about engineering and education;
- Become aware of the theoretical and practical issues of learning, instruction, and assessment as these concern the design of educational environments and technologies;
- Apply design research methods to inform and validate designs involving educational issues.
- Articulate their own view of the design of educational tools and become more confident about their ability to work as an engineer and educational designer.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

MEC ENG 206A Introduction to Robotics 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
This course is an introduction to the field of robotics. It covers the fundamentals of kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course deals with forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, autonomous vehicles, and other areas.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Sreenath

MEC ENG C206A Introduction to Robotics 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
This course is an introduction to the field of robotics. It covers the fundamentals of kinematics, dynamics, control of robot manipulators, robotic vision, sensing, forward & inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, & control. We will present techniques for geometric motion planning & obstacle avoidance. Open problems in trajectory generation with dynamic constraints will also be discussed. The course also presents the use of the same analytical techniques as manipulation for the analysis of images & computer vision. Low level vision, structure from motion, & an introduction to vision & learning will be covered. The course concludes with current applications of robotics.

Rules & Requirements

Prerequisites: Familiarity with linear algebra at level of EECS 16A/ EECS 16B or MATH 54. Experience doing coding in python at the level of COMPSCI 61A. Preferred: experience developing software at level of COMPSCI 61B and experience using Linux. EECS 120 is not required, but some knowledge of linear systems may be helpful for the control of robots

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Sastry, Sreenath

Formerly known as: Electrical Engin and Computer Sci 206A

Also listed as: EECS C206A

MEC ENG C206B Robotic Manipulation and Interaction 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
This course is a sequel to EECS C106A/206A, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic
manipulators coordinating with each other and interacting with the environment. Concepts will include
an introduction to grasping and the constrained manipulation, contacts and force control for interaction
with the environment. We will also cover active perception guided manipulation, as well as the
manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot
interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and
locomotion.

Rules & Requirements

Prerequisites: Students are expected to have taken EECS C106A / BioE C106A / ME C106A / ME C206A/ EECS C206A or an equivalent course. A strong programming background, knowledge of Python and Matlab, and some coursework in feedback controls (such as EE C128 / ME C134) are also useful. Students who have not taken EECS C106A / BioE C106A / ME C106A / ME C206A/ EECS C206A should have a strong programming background, knowledge of Python and Matlab, and exposure to linear algebra, and Lagrangian dynamics

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Bajcsy, Sastry

Formerly known as: Electrical Engin and Computer Sci 206B

Also listed as: EECS C206B

MEC ENG C210 Advanced Orthopedic Biomechanics 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
Students will learn the application of engineering concepts including statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory, and materials behavior. Topics will include forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk predication of bones; and bone adaptation. Students will be challenged in a MATLAB-based project to integrate the course material in an attempt to gain insight into contemporary design/analysis/problems.

Objectives & Outcomes

Course Objectives: The purpose of this course is twofold:

- to learn the fundamental concepts of orthopaedic biomechanics;
- to enhance skills in mechanical engineering and bioengineering by analyzing the mechanical behavior of various complex biomedical problems.

Student Learning Outcomes: Working knowledge of various engineering concepts such as composite beam theory, beam-on-elastic-foundation theory, Hertz contact theory and MATLAB-based optimization design analysis. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved.

Rules & Requirements

Prerequisites: ME C85/CE C30 or Bio Eng 102; concurrent enrollment OK. Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Credit Restrictions: Students will not receive credit for this course if they have taken ME C176/Bio E C119.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: O'Connell, Keaveny

Also listed as: BIO ENG C209

MEC ENG 211 The Cell as a Machine 3 Units

Terms offered: Fall 2019, Fall 2015, Fall 2013
This course offers a modular and systems mechanobiology (or "machine") perspective of the cell. Two vitally important components of the cell machinery will be studied in depth: (1) the integrin-mediated focal adhesions system that enables the cell to adhere to, and communicate mechano-chemical signals with, the extracellular environment, and (2) the nuclear pore complex, a multi-protein gateway for traffic in and out of the nucleus that regulates gene expression and affects protein synthesis.

Rules & Requirements

Prerequisites: Mathematics 54; Physics 7A; graduate standing

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mofrad

MEC ENG C212 Heat and Mass Transport in Biomedical Engineering 3 Units

Terms offered: Spring 2008, Fall 2007, Spring 2006, Spring 2005
Fundamental processes of heat and mass transport in biological systems; organic molecules, cells, biological organs, whole animals. Derivation of mathematical models and discussion of experimental procedures. Applications to biomedical engineering.

Rules & Requirements

Prerequisites: 106 and 109 (106 and 109 may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Mechanical Engineering 212

Also listed as: BIO ENG C212

MEC ENG C213 Fluid Mechanics of Biological Systems 3 Units

Terms offered: Fall 2023, Spring 2019, Spring 2016
Fluid mechanical aspects of various physiological systems, the circulatory, respiratory, and renal systems. Motion in large and small blood vessels. Pulsatile and peristaltic flows. Other biofluidmechanical flows: the ear, eye, etc. Instrumentation for fluid measurements in biological systems and for medical diagnosis and applications. Artificial devices for replacement of organs and/or functions, e.g. blood oxygenators, kidney dialysis machines, artificial hearts/circulatory assist devices.

Rules & Requirements

Prerequisites: 106 or equivalent; 265A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Berger, Liepmann

Also listed as: BIO ENG C213

MEC ENG C214 Advanced Tissue Mechanics 3 Units

Terms offered: Spring 2025, Spring 2018, Spring 2017, Spring 2015
The goal of this course is to provide a foundation for characterizing and understanding the mechanical behavior of load-bearing tissues. A variety of mechanics topics will be introduced, including anisotropic elasticity and failure, cellular solid theory, biphasic theory, and quasi-linear viscoelasticity (QLV) theory. Building from this theoretical basis, we will explore the constitutive behavior of a wide variety of biological tissues. After taking this course, students should have sufficient background to independently study the mechanical behavior of most biological tissues. Formal discussion section will include a seminar series with external speakers.

Rules & Requirements

Prerequisites: 102A, 176, 185; graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Also listed as: BIO ENG C214

MEC ENG C215 Advanced Structural Aspects of Biomaterials 4 Units

Terms offered: Fall 2024, Spring 2023, Fall 2020
This course covers the structure and mechanical functions of load bearing tissues and their replacements. Biocompatibility of biomaterials and host response to structural implants are examined. Quantitative treatment of biomechanical issues and constitutive relationships of materials are covered in order to design implants for structural function. Material selection for load bearing applications including reconstructive surgery, orthopedics, dentistry, and cardiology are addressed.

Rules & Requirements

Credit Restrictions: Students should not receive credit if they've taken ME ME C117 or Bio Eng C117.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Also listed as: BIO ENG C222

MEC ENG C216 Molecular Biomechanics and Mechanobiology of the Cell 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021, Spring 2020
This course develops and applies scaling laws and the methods of continuum and statistical mechanics to understand micro- and nano-scale mechanobiological phenomena involved in the living cell with particular attention the nucleus and the cytoskelton as well as the interactions of the cell with the extracellular matrix and how these interactions may cause changes in cell architecture and biology, consequently leading to functional adaptation or pathological conditions.

Objectives & Outcomes

Course Objectives: This course, which is open to graduate students in diverse disciplines ranging from engineering to biology to chemistry and physics, is aimed at exposing students to subcellular biomechanical phenomena spanning scales from molecules to the whole cell.

Student Learning Outcomes: The students will develop tools and skills to (1) understand and analyze subcelluar biomechanics and transport phenomena, and (2) ultimately apply these skills to novel biological and biomedical applications.

Rules & Requirements

Prerequisites: MATH 54, PHYSICS 7A; BIO ENG 102 or MEC ENG C85; or instructor’s consent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mofrad

Also listed as: BIO ENG C215

MEC ENG C217 Biomimetic Engineering -- Engineering from Biology 3 Units

Terms offered: Fall 2017, Spring 2014, Fall 2010
Study of nature's solutions to specific problems with the aim of determining appropriate engineering analogs. Morphology, scaling, and design in organisms applied to engineering structures. Mechanical principles in nature and their application to engineering devices. Mechanical behavior of biological materials as governed by underlying microstructure, with the potential for synthesis into engineered materials. Trade-offs between redundancy and efficiency. Students will work in teams on projects where they will take examples of designs, concepts, and models from biology and determine their potential in specific engineering applications.

Rules & Requirements

Prerequisites: Graduate standing in engineering or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Dharan

Also listed as: BIO ENG C217/INTEGBI C217

MEC ENG 218N Introduction to Nanotechnology and Nanoscience 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
UG and Grad. introduction to nanotechnology and nanoscience. The course has two components:1) Students receive a set of formal lectures introducing nanotechnology and nanoscience, covering nanofabrication technology (how one achieves the nanometer length scale, from "bottom up" to "top down" technologies), the interdisciplinary nature of nanotechnology and nanoscience (including areas of chemistry, material science, physics, and molecular biology), examples of nanoscience phenomena (the crossover from bulk to quantum mechanical properties) and applications from integrated circuits, quantum computing, MEMS, and bioengineering 2) Projects. Students are asked to present on a variety of current journal papers to the class & lead discussion.

Objectives & Outcomes

Course Objectives: To introduce and provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates.
To introduce students to inter- and multi-disciplinary science and engineering.

Student Learning Outcomes: A recognition of the need for, and an ability to engage in life-long learning. A knowledge of contemporary issues.
An ability to apply knowledge of mathematics, science, and engineering.
An ability to function on multidisciplinary teams.
An ability to identify, formulate, and solve engineering problems. An ability to communicate effectively.
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

Rules & Requirements

Prerequisites: Chem 1A, Physics 7B, Physics 7C, Engineering 45. BIO 1A and Chem 1B preferred

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Lin

MEC ENG C218 Introduction to MEMS Design 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022, Spring 2021
Physics, fabrication, and design of micro-electromechanical systems (MEMS). Micro and nanofabrication processes, including silicon surface and bulk micromachining and non-silicon micromachining. Integration strategies and assembly processes. Microsensor and microactuator devices: electrostatic, piezoresistive, piezoelectric, thermal, magnetic transduction. Electronic position-sensing circuits and electrical and mechanical noise. CAD for MEMS. Design project is required.

Rules & Requirements

Prerequisites: Graduate standing in engineering or science; undergraduates with consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Nguyen, Pister

Formerly known as: Electrical Engineering C245, Mechanical Engineering C218

Also listed as: EL ENG C247B

MEC ENG 219 Introduction to Microelectromechanical Systems 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Fundamentals of microelectromechanical systems including design, fabrication of microstructures; surface micromachining, bulk-micromachining, LIGA, and other micro machining processes; fabrication principles of integrated circuit device and their applications for making MEMS devices; high-aspect-ratio microstructures; scaling issues in the micro scale (heat transfer, fluid mechanics and solid mechanics); device design, analysis, and mask layout.

Objectives & Outcomes

Course Objectives: The course aims to provide basic understanding of micromachining processes, including surface micromachining, bulk micromachining and LIGA. Students should learn the design and fabrication aspects of MEMS by using computer-aided-design tools to design and draw their own microstructures.

Student Learning Outcomes: ABET: A recognition of the need for, and an ability to engage in life-long learning; a knowledge of contemporary issues; an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
ABET: An ability to apply knowledge of mathematics, science, and engineering; an ability to design a system, component, or process to meet desired needs; an ability to identify, formulate, and solve engineering problems.
Students completing this course will have: The ability to identify, formulate, and solve problems relating to MEMS manufacturing.
Students should be able to design micro-machining process flows by using fundamental skills learned in the class and combine with knowledge from other courses to construct their own micro-machines.
The ability to apply mathematics, basic science, and engineering science to the solution of MEMS manufacturing problems.
The ability to design a component and select a fabrication process or sequence of processes suitable for production of a MEMS device.
The ability to identify, formulate, and solve problems relating to MEMS manufacturing.
The ability to interpret the results of engineering investigations.

Rules & Requirements

Prerequisites: MEC ENG 100 and PHYSICS 7B

Credit Restrictions: Students will receive no credit for MEC ENG 219 after completing MEC ENG 219, or MEC ENG 219. A deficient grade in MEC ENG 219 may be removed by taking MEC ENG 219, or MEC ENG 219.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Lin

MEC ENG C219 Parametric and Optimal Design of MEMS 3 Units

Terms offered: Spring 2013, Spring 2012, Spring 2011
Parametric design and optimal design of MEMS. Emphasis on design, not fabrication. Analytic solution of MEMS design problems to determine the dimensions of MEMS structures for specified function. Trade-off of various performance requirements despite conflicting design requirements. Structures include flexure systems, accelerometers, and rate sensors.

Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Lin, Pisano

Formerly known as: 219

Also listed as: EL ENG C246

MEC ENG 220 Precision Manufacturing 3 Units

Terms offered: Fall 2015, Fall 2013, Fall 2012
Introduction to precision engineering for manufacturing. Emphasis on design and performance of precision machinery for manufacturing. Topics include machine tool elements and structure, sources of error (thermal, static, dynamic, process related), precision machining processes and process models (diamond turning and abrasive (fixed and free) processes), sensors for process monitoring and control, metrology, actuators, machine design case studies and examples of precision component manufacture.

Rules & Requirements

Prerequisites: 101, 102B, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Dornfeld

MEC ENG C220D Input/Output Methods for Compositional System Analysis 2 Units

Terms offered: Prior to 2007
Introduction to input/output concepts from control theory, systems as operators in signal spaces, passivity and small-gain theorems, dissipativity theory, integral quadratic constraints. Compositional stabilility and performance certification for interconnected systems from subsystems input/output properties. Case studies in multi-agent systems, biological networks, Internet congestion control, and adaptive control.

Objectives & Outcomes

Course Objectives: Standard computational tools for control synthesis and verification do not scale well to large-scale, networked systems in emerging applications. This course presents a compositional methodology suitable when the subsystems are amenable to analytical and computational methods but the interconnection, taken as a whole, is beyond the reach of these methods. The main idea is to break up the task of certifying desired stability and performance properties into subproblems of manageable size using input/output properties. Students learn about the fundamental theory, as well as relevant algorithms and applications in several domains.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Arcak, Packard

Also listed as: EL ENG C220D

MEC ENG 221 Graduate Introduction to Lean Manufacturing Systems 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2021
Fundamentals of lean manufacturing systems including manufacturing fundamentals, unit operations and manufacturing line considerations for work in process (WIP), manufacturing lead time (MLT), economics, quality monitoring; high mix/low volume (HMLV) systems fundamentals including just in time (JIT), kanban, buffers and line balancing; class project/case studies for design and analysis of competitive manufacturing systems.

Objectives & Outcomes

Course Objectives: This course will enable students to analyze manufacturing lines in order to understand the production process and improve production efficiency. The course provides practical knowledge and skills that can be applied in industry, covering the complete manufacturing system from production planning to quality control. Students are given a chance to practice and implement what they learn during lectures by conducting projects with local or global manufacturing companies.

Student Learning Outcomes: Students will understand the whole scope of manufacturing systems from production planning to quality control, which can be helpful to set up manufacturing lines for various products. Students will be capable of identifying sources of manufacturing problems by analyzing the production line and produce multi-level solutions to optimize manufacturing efficiency.

Rules & Requirements

Prerequisites: Graduate standing in Engineering, or consent of instructor

Credit Restrictions: Students will not receive credit for this course after taking ME 101.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: McMains

MEC ENG C223 Polymer Engineering 3 Units

Terms offered: Fall 2025, Fall 2023, Fall 2021
This course provides an overview of engineering polymers and an introduction to polymer physics. The molecular variables that play a role in structural performance of polymer systems are examined. The assessment of structural behavior of macromolecules and engineering polymers are addressed for functional design in broad applications including medical devices as well as product design. Environmental impact and novel applications of plastics are evaluated.

Rules & Requirements

Prerequisites: MECENG 108, BIOENG 102, MATSCI 113 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Also listed as: BIO ENG C223

MEC ENG 224 Mechanical Behavior of Engineering Materials 3 Units

Terms offered: Spring 2020, Fall 2018, Fall 2016
This course covers elastic and plastic deformation under static and dynamic loads. Prediction and prevention of failure by yielding, fracture, fatigue, creep, corrosion, and wear. Basic elasticity and plasticity theories are discussed.

Rules & Requirements

Prerequisites: Civil and Environmental Engineering 130 or 130N; Engineering 45

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 224A Failure Analysis of Structural Material 3 Units

Terms offered: Spring 2024, Spring 2022
This course covers the fundamental materials science, mechanical behavior and failure modes of structural materials. Case studies of failure analysis involving materials, designs and ethical considerations are presented. The course utilizes three team-based projects. All course content is accessible in B-courses.
Rules & Requirements

Prerequisites: MECENG 108 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Pruitt

MEC ENG C225 Deformation and Fracture of Engineering Materials 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2022
This course covers deformation and fracture behavior of engineering materials for both monotonic and cyclic loading conditions.
Rules & Requirements

Prerequisites: Civil Engineering 130, Engineering 45

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Ritchie, Pruitt, Komvopoulos

Formerly known as: Materials Science and Engineering C212, Mechanical Engineering C225

Also listed as: MAT SCI C212

MEC ENG 226 Tribology 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Surface interactions. Fundamentals of contact mechanics. Friction theories. Types of measurement of wear. Response of materials to surface tractions. Plastic deformation, void/crack nucleation and crack propagation. Delamination wear. Microstructural effects in wear processes. Mechanics of layered media. Solid film and boundary liquid film lubrication. Friction and wear of polymers and fiber-reinforced polymeric composites. Brief introduction to metal cutting and tool wear mechanisms.
Rules & Requirements

Prerequisites: 102B, 104, 108

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Komvopoulos

MEC ENG 226L The Science and Engineering of Cooking 4 Units

Terms offered: Fall 2024, Fall 2022, Spring 2022
This course will discuss concepts from the physical sciences and engineering (e.g. heat and mass transfer, phase transitions, fluid mechanics, etc.) that serve as a foundation for everyday cooking and haute cuisine. The course will integrate the expertise of visiting chefs from the Bay Area (and beyond) who will serve as guest lecturers and present their cooking techniques. These unique opportunities will be complemented by lectures that investigate in-depth the science and engineering that underlie these techniques.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Sohn

MEC ENG 227 Mechanical Behavior of Composite Materials 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
Response of composite materials (fiber and particulate-reinforced materials) to static, cyclic, creep and thermomechanical loading. Manufacturing process-induced variability, and residual stresses. Fatigue behavior,fracture mechanics and damage development. Role of the reinforcement-matrix interface in mechanical behavior. Environmental effects. Dimensional stability and thermal fatigue. Application to polymer, metal, ceramic, and carbon matrix composites.

Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Dharan

MEC ENG 229 Design of Basic Electro-Mechanical Devices 3 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
Fundamental principles of magnetics, electro-magnetics, and magnetic materials as applied to design and operation of electro-mechanical devices. Type of device to be used in a particular application and dimensions of parts for the overall design will be discussed. Typical applications covered will be linear and rotary actuators, stepper motors, AC motors, and DC brush and brushless motors. A design project is required.

Rules & Requirements

Prerequisites: EECS 100, graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 230A Predictive Control 2 Units

Terms offered: Fall 2018
Advanced optimization, polyhedra manipulation, and multiparametric programming. Robust Invariant set theory. Analysis and design of model predictive controllers (MPC) for linear and nonlinear systems. Stochastic MPC. Learning MPC. Computational oriented models of hybrid systems. Analysis and design of constrained predictive controllers for hybrid systems.

Objectives & Outcomes

Course Objectives: The course is designed for graduate students who want to expand their knowledge on model predictive control. 80% will be focusing on advanced theory. 20% on applications.

Student Learning Outcomes: At the end of the course, the students will write a theoretical paper on MPC and/or will design an application where the advanced theory is implemented.

Rules & Requirements

Prerequisites: ME C232 and ME C231A

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Borrelli

MEC ENG 230B Advanced System Theory: Control-Oriented Robustness Analysis 2 Units

Terms offered: Prior to 2007
Theoretical development of the common methods in control system robustness analysis, including general dissipative systems and supply rates, structured singular value, and integral quadratic constraints. Transforming theory into pragmatic algorithms. Use cases in industrial examples.

Objectives & Outcomes

Course Objectives: The course is designed for graduate students who want to quickly expand their knowledge on robustness analysis comprising one part of a complete validation process for complex feedback systems. Students will learn about theory, algorithms, applications and existing software.

Student Learning Outcomes: Students will gain a deep understanding of the modeling assumptions and precise results offered by current state-of-the-art robustness analysis techniques. The wide applicability as well as the limitations of the techniques will be emphasized. The course concludes with a self-directed project, covering a theoretical, algorithmic or applications-oriented issue of interest to each individual student.

Rules & Requirements

Prerequisites: Basic graduate background in linear algebra and linear differential equations (ME C232 or EECS 221A or equivalent)

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Packard

MEC ENG C231A Experiential Advanced Control Design I 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Experience-based learning in the design of SISO and MIMO feedback controllers for linear systems. The student will master skills needed to apply linear control design and analysis tools to classical and modern control problems. In particular, the participant will be exposed to and develop expertise in two key control design technologies: frequency-domain control synthesis and time-domain optimization-based approach.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Also listed as: EL ENG C220B

MEC ENG C231B Experiential Advanced Control Design II 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
Experience-based learning in design, analysis, & verification of automatic control for uncertain systems. The course emphasizes use of practical algorithms, including thorough computer implementation for representative problems. The student will master skills needed to apply advanced model-based control analysis, design, and estimation to a variety of industrial applications. First-principles analysis is provided to explain and support the algorithms & methods. The course emphasizes model-based state estimation, including the Kalman filter, and particle filter. Optimal feedback control of uncertain systems is also discussed (the linear quadratic Gaussian problem) as well as considerations of transforming continuous-time to discrete time.

Rules & Requirements

Prerequisites: Undergraduate controls course (e.g. MECENG 132, ELENG 128) Recommended: MECENG C231A/ELENG C220B and either MECENG C232/ELENG C220A or ELENG 221A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mueller

Also listed as: EL ENG C220C

MEC ENG C232 Advanced Control Systems I 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Input-output and state space representation of linear continuous and discrete time dynamic systems. Controllability, observability, and stability. Modeling and identification. Design and analysis of single and multi-variable feedback control systems in transform and time domain. State observer. Feedforward/preview control. Application to engineering systems.

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Borrelli, Horowitz, Tomizuka, Tomlin

Also listed as: EL ENG C220A

MEC ENG 233 Advanced Control Systems II 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
Linear Quadratic Optimal Control, Stochastic State Estimation, Linear Quadratic Gaussian Problem, Loop Transfer Recovery, Adaptive Control and Model Reference Adaptive Systems, Self Tuning Regulators, Repetitive Control, Application to engineering systems.

Rules & Requirements

Prerequisites: 232

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Tomizuka, Horowitz

MEC ENG 234 Multivariable Control System Design 3 Units

Terms offered: Fall 2016, Spring 2015, Spring 2011
Analysis and synthesis techniques for multi-input (MIMO) control systems. Emphasis is on the effect that model uncertainty has on the design process.

Rules & Requirements

Prerequisites: 232 or EECS 221A, as well as firm foundation in classical control

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Packard, Poolla

MEC ENG 235 Design of Microprocessor-Based Mechanical Systems 4 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
This course provides preparation for the conceptual design and prototyping of mechanical systems that use microprocessors to control machine activities, acquire and analyze data, and interact with operators. The architecture of microprocessors is related to problems in mechanical systems through study of systems, including electro-mechanical components, thermal components, and a variety of instruments. Laboratory exercises lead through studies of different levels of software.

Rules & Requirements

Prerequisites: 132, or C134/Electrical Engineering and Computer Science C128, or any basic undergraduate course in controls

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Summer: 10 weeks - 4.5 hours of lecture and 4.5 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 236C Vehicle Dynamics & Control 4 Units

Terms offered: Spring 2025, Spring 2023, Spring 2021
Physical understanding of automotive vehicle dynamics: simple lateral, longitudinal and ride quality models. An overview of active safety systems will be intros including basic concepts and terminology, the state-of-the-art development, and basic principles of systems such as ABS, traction control, dynamic stability control, and roll stability control.Passive, semi-active and active suspension systems will be analyzed. Concepts of autonomous vehicle technology including drive-by-wire and steer-by-wire systems, adaptive cruise control and lane keeping systems. Design of software control systems for an actual 1/10 scale race vehicle.
Objectives & Outcomes

Course Objectives: Develop skills in using professional computer-aided control system design and analysis tools, e.g, Matlab/Simulink and ROS, to explore properties of dynamic systems composed of a large number sub-systems such as sensors and actuators.
Develop the analytical skills necessary to quantitatively predict the behavior of open-loop and closed-loop systems.
Experimental design will be complemented with a careful analysis of the performance by simulation.
Feedback control systems will be presented that are currently being used in active safety systems, the student will be expected to design feedback control systems for an actual 1/10 scaled vehicle platform which will be distributed to every group of two students in the class.
Present and motivate the appropriate level of dynamic modeling that is required to analyze the performance of vehicle control systems.
The development of such models is as much of an art as a science in that the models must be kept as simple as possible so that real-time controller implementation can be achieved while retaining the fundamental stability and dynamic response characteristics.

Student Learning Outcomes: Assess the stability of dynamic systems using differential equation theory, apply frequency-response methods to assess system response to external disturbances, sensor noise and parameter variations.

Expected to design feedback control systems for an actual 1/010 scaled vehicle platform which will be distributed to every group of two students in the class

Follow the literature on these subjects and perform independent design, research and development work in this field
Formulate simple but accurate dynamic models for automotive longitudinal, lateral and ride quality analysis.

Have a basic understanding of modern automotive safety systems including ABS, traction control, dynamic stability control and roll control.

Students should be able to follow the literature on these subjects, perform independent design, be able to design vehicle dynamics control systems for a 1/10 scale vehicle.

Rules & Requirements

Prerequisites: MATH 52, MATH 53, 54, PHYSICS 7A, PHYSICS 7B, ENGIN 7; and MEC ENG 132 (for Mechanical Engineering undergraduate students) or MEC ENG C231A (for Mechanical Engineering graduate students)

Credit Restrictions: Students will receive no credit for MEC ENG 236C after completing MEC ENG 131. A deficient grade in MEC ENG 236C may be removed by taking MEC ENG 131.

MEC ENG 236HL Hardware laboratory: Dynamics and Control of Autonomous Flight 1 Unit

Terms offered: Prior to 2007
This course supplements ME 236U, Introduction to Control of Unmanned Aerial Vehicles. The aim is to provide hardware experiments corresponding to the virtual lab exercises provided in ME236U. Students will work in teams.
Objectives & Outcomes

Course Objectives: •
Embedded programming and constraints following there from.
•
Evaluating data from real experiments, with corresponding issues.
•
Experimental flight hardware.
•
Real noisy sensors.

Student Learning Outcomes: evaluate experimental data
explain utility of simulations and hardware experiments for development
program an embedded flight controller

Rules & Requirements

Prerequisites: Co requisite 236U

Credit Restrictions: Students will receive no credit for MEC ENG 236HL after completing MEC ENG 236SL.

Hours & Format

Fall and/or spring: 6 weeks - 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mueller

MEC ENG 236SL Software laboratory: Dynamics and Control of Autonomous Flight 1 Unit

Terms offered: Fall 2024
This course complements MEC ENG 236U, Introduction to Control of Unmanned Aerial Vehicles. The aim is to provide (virtual) laboratory experiments corresponding to the theory provided in ME236U. Students may work alone or in teams.

Objectives & Outcomes

Course Objectives: embedded programming and constraints following therefrom
evaluating data from experiments with corresponding issues
real (i.e., noisy) sensors
simulated flight hardware

Student Learning Outcomes: data evaluation
non-idealities in real sensors and actuators
programming embedded computers

Rules & Requirements

Prerequisites: Co requisite of MEC ENG 236U

Credit Restrictions: Students will receive no credit for MEC ENG 236SL after completing MEC ENG 236HL.

Hours & Format

Fall and/or spring: 6 weeks - 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mueller

MEC ENG 236U Dynamics and Control of Autonomous Flight 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
This course is a room share with ME136, and teaches students the dynamic analysis and control of uninhabited aerial vehicles (UAVs). The course covers modeling and dynamics of aerial vehicles, common control strategies, sensing and estimation. A laboratory sequence allows students to apply knowledge on a real quadcopter system, by programming a microcontroller to control a UAV.

Objectives & Outcomes

Course Objectives: Introduce the students to analysis, modeling, and control of unmanned aerial vehicles. Lectures will cover:

- Principle forces acting on a UAV, including aerodynamics of propellers
- The kinematics and dynamics of rotations, and 3D modeling of vehicle dynamics
- Typical sensors, and their modeling
- Typical control strategies, and their pitfalls
- Programming a microcontroller

During the laboratory sessions, students will apply these skills to create a model-based controller for a UAV.

Rules & Requirements

Prerequisites: Introductory control (Mechanical Engineering 132 or similar), Dynamics (Mechanical Engineering 104 or similar). Taken concurrently: a graduate controls class (Mechanical Engineering C232/ Electrical Engineering C220A or similar)

Credit Restrictions: Student will not receive credit for this course if they have taken Mechanical Engineering 136.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mueller

MEC ENG C236 Control and Optimization of Distributed Parameters Systems 3 Units

Terms offered: Fall 2017, Spring 2016, Spring 2015, Spring 2014
Distributed systems and PDE models of physical phenomena (propagation of waves, network traffic, water distribution, fluid mechanics, electromagnetism, blood vessels, beams, road pavement, structures, etc.). Fundamental solution methods for PDEs: separation of variables, self-similar solutions, characteristics, numerical methods, spectral methods. Stability analysis. Adjoint-based optimization. Lyapunov stabilization. Differential flatness. Viability control. Hamilton-Jacobi-based control.

Rules & Requirements

Prerequisites: ENGIN 7 and MATH 54; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Also listed as: CIV ENG C291F/EL ENG C291

MEC ENG 237 Control of Nonlinear Dynamic Systems 3 Units

Terms offered: Spring 2016, Spring 2015, Fall 2013
Fundamental properties of nonlinear systems. Stability of nonlinear systems via Lyapunov's Direct Method. Controllability and observability of nonlinear systems. Controller design of nonlinear systems including feedback linearization and sliding mode control. Design of nonlinear discrete and adaptive controllers. Nonlinear observers and compensators.

Objectives & Outcomes

Course Objectives: To develop non-simulative/analytical tools to predict the stability and performance of nonlinear systems and to develop an appreciation for the differences between linear and nonlinear systems such as multiple equilibrium points, initial condition dependent stability. To develop controller synthesis methods for nonlinear and uncertain dynamic systems.

Student Learning Outcomes: The ability to design, evaluate and implement closed loop controllers for highly nonlinear and uncertain systems.

Rules & Requirements

Prerequisites: ME C232

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG C237 Nonlinear Systems 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2022, Spring 2021
Basic graduate course in nonlinear systems. Nonlinear phenomena, planar systems, bifurcations, center manifolds, existence and uniqueness theorems. Lyapunov's direct and indirect methods, Lyapunov-based feedback stabilization. Input-to-state and input-output stability, and dissipativity theory. Computation techniques for nonlinear system analysis and design. Feedback linearization and sliding mode control methods.

Rules & Requirements

Prerequisites: MATH 54 (undergraduate level ordinary differential equations and linear algebra)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Arcak, Tomlin, Kameshwar

Also listed as: EL ENG C222

MEC ENG 238 Advanced Micro/Nano Mechanical Systems Laboratory 3 Units

Terms offered: Spring 2018, Spring 2013
This hands-on laboratory course focuses on the mechanical engineering principles that underlie the design, fabricaton, and operation of micro/nanoscale mechanical systems, including devices made by nanowire/nanotube syntheses; photolithography/soft lithography; and molding processes. Each laboratory will have different focuses for basic understanding of MEMS/NEMS systems from prototype constructions to experimental testings using mechanical, electrical, or optical techniques.

Rules & Requirements

Prerequisites: EE 16A or 40, Physics 7B, ME 106, (ME119 or ME118 are highly recommended but not mandatory)

Credit Restrictions: Students will receive no credit for Mechanical Engineering 238 after taking Mechanical Engineering 138.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 239 Robotic Locomotion 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
This course will provide students with a solid understanding of robotic locomotion and the use of dynamics, control and embedded microcomputers in designing artificial legs such as prosthetics, orthotics and exoskeletons.

Objectives & Outcomes

Course Objectives: 1.The course objectives are to train students to be able to design artificial legs, select and design components of the robotic legs.
2. Conduct various analyses on the legs' performance, propose and study practical applications such as orthotics and prosthetics in medical field, back support, knee support and shoulder support exoskeletons in industrial field and recreational exoskeletons.

Student Learning Outcomes: (a) An ability to apply knowledge of mathematics, science, and engineering.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, formulate, and solve engineering problems.
(f) An understanding of professional and ethical responsibility.
(g) An ability to communicate effectively.
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
(i) A recognition of the need for, and an ability to engage in life-long learning.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements

Prerequisites: A preliminary course in the design and control of mechanical systems

Credit Restrictions: Students will receive no credit for MEC ENG 239 after completing MEC ENG 139. A deficient grade in MEC ENG 239 may be removed by taking MEC ENG 139.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Kazerooni

MEC ENG 240A Advanced Marine Structures I 3 Units

Terms offered: Fall 2013, Spring 2013, Spring 2012
This course introduces a probabilistic description of ocean waves and wave loads acting on marine structures. These topics are followed with discussion of structural strength and reliability analysis.

Rules & Requirements

Prerequisites: Graduate standing; Statistics 25 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mansour

MEC ENG 240B Advanced Marine Structures II 3 Units

Terms offered: Spring 2015, Fall 2014, Spring 2014
This course is concerned with the structural response of marine structures to environmental loads. Overall response of the structure as well as the behavior of its members under lateral and compressive loads are discussed.

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mansour

MEC ENG 241A Marine Hydrodynamics I 3 Units

Terms offered: Fall 2016, Fall 2015, Spring 2014
Navier-Stokes Equations. Boundary-layer theory, laminar, and turbulent. Frictional resistance. Boundary layer over water surface. Separated flow modeling. Steady and unsteady flow. Momentum theorems. Three-dimensional water-wave theory. Formulation of wave resistance of ships. Michell's solution. Wave patterns. Applications.

Objectives & Outcomes

Course Objectives: To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

Student Learning Outcomes: Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

Rules & Requirements

Prerequisites: Mechanical Engineering 165 recommended or graduate standing

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Yeung

MEC ENG 241B Marine Hydrodynamics II 3 Units

Terms offered: Spring 2017, Spring 2016, Fall 2014
Momentum analysis for bodies moving in a fluid. Added-mass theory. Matched asymptotic slender-body theory. Small bodies in a current. Theory of motion of floating bodies with and without forward speed. Radiation and diffraction potentials. Wave forces. Hydro-elasticity formulation. Ocean-wave energy. Memory effects in time domain. Second-order formulation. Impact hydrodynamics, Hydrofoil theory and lifting surface.

Objectives & Outcomes

Course Objectives: To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and renewable ocean energy

Student Learning Outcomes: Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

Rules & Requirements

Prerequisites: 260A or 241A, or CEE 200A recommended

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Yeung

MEC ENG 242 Ocean-Environment Fluid Mechanics 3 Units

Terms offered: Fall 2024, Fall 2022, Spring 2020
Viscous-fluid flow, boundary-layer theory surface waves, ship waves, and applications. Ocean environment. Physical properties and characteristics of the oceans. Global conservation laws. Surface-waves generation. Gravity-wave mechanics, kinematics, and dynamics. Design consideration of ocean vehicles and systems. Model-testing techniques. Prediction of resistance and response in waves--physical modeling and computer models.

Objectives & Outcomes

Course Objectives: To provide training of mechanical engineers to understand the unique characteristics of the ocean environment, local and global scale, and to provide background on engineering and design tools that are commonly used by engineers working with system and component designs of ocean, marine energy, and ship systems.

Student Learning Outcomes: At the end of the course, the students should understand general scientific properties that characterize the main body of the oceans; understand components of drags that contribute to the resistance of a marine vehicle and the associated engineering skills in model-testing that quantify the drag characteristics of a ship hull; comprehend simple harmonic surface-wave theory, with strong realization of the underlying concepts of wave kinematics, wave energy, and group velocity.

Rules & Requirements

Prerequisites: ME 106 OR CEE 100 OR equivalent fluids/hydro undergraduate class

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mäkiharju

MEC ENG 243 Advanced Methods in Free-Surface Flows 3 Units

Terms offered: Spring 2016, Fall 2012, Spring 2009
Analytical and numerical methods in free-surface problems. Elements of inviscid external lifting and nonlifting flows. Analytical solutions in special coordinates systems. Integral-equation methods: formulations and implementations. Multiple-bodies interaction problems. Free-surface Green functions in two and three dimensions. Hybrid integral-equation methods. Finite-element formulations. Variational forms in time-harmonic flows. Finite-difference forms, stability, and accuracy. Boundary-fitted coordinates methods. Unsteady linearized wave-body interaction in time domain. Nonlinear breaking waves calculations. Particle dynamics. Extensive hands-on experience of microcomputers and/or workstations in developing solution.

Objectives & Outcomes

Course Objectives: To present a relatively broad spectrum of analytical and numerical methods commonly used in tackling wave-body interaction problems. Topics covered include classical techniques in special coordinate systems, modern computational techniques based on boundary-integral, finite-element, and boundary-fitted coordinates methods. Lectures focus on formulations and implementation techniques. Students are given opportunities to implement methods discussed in class on workstations or mainframe.

Student Learning Outcomes: Students will be conversant and have abilities to handle fluid-structure interactions problems with free-surface present.

Rules & Requirements

Prerequisites: ME 260A or CEE 200A; ME 241B recommended or with Instructor’s permission

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Yeung

MEC ENG 245 Oceanic and Atmospheric Waves 3 Units

Terms offered: Fall 2024, Spring 2021, Spring 2018
Covers dynamics of wave propagation in the ocean and the atmosphere. Specifically, formulation and properties of waves over the surface of a homogenous fluid, interfacial waves in a two-/multi-layer density stratified fluid, and internal waves in a continuous stratification will be discussed.
Rules & Requirements

Prerequisites: Mechanical Engineering 241A or 241B or 260A or Civil and Environmental Engineering 200A or equivalent courses

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 246 Advanced Energy Conversion Principles 3 Units

Terms offered: Spring 2025, Fall 2018, Spring 2018
Covers the fundamental principles of energy conversion processes, followed by development of theoretical and computational tools that can be used to analyze energy conversion processes. Also introduces the use of modern computational methods to model energy conversion performance characteristics of devices and systems. Performance features, sources of inefficiencies, and optimal design strategies are explored for a variety of applications.
Objectives & Outcomes

Course Objectives: This class provides students with an understanding of the thermophysical principles that govern energy conversion processes of different types, and will introduce them to modern computational methods for modeling the performance of energy conversion processes, devices and systems. This course is a capstone experience for ME students, synthesizing thermodynamics, fluid dynamics, heat transfer and computational analysis tools to facilitate engineering design analysis.

Student Learning Outcomes: This course will provide a foundation for design analysis of energy conversion systems encountered in a variety of applications.

Rules & Requirements

Prerequisites: Engineering 7, Mechanical Engineering 40, Mechanical Engineering 106, and Mechanical Engineering 109 or their equivalents

Credit Restrictions: Students will receive no credit for Mechanical Engineering 246 after taking Mechanical Engineering 146.

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Carey

MEC ENG 248 Experimental Methods in Single-and Multiphase Flows 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2000

Fundamentals of modern single & multiphase flow measurement techniques, w. intrusive and non-intrusive techniques. Students will learn the fundamentals of particle image velocimetry, electrical impedance measurements, X-ray based multiphase flow measurements, and advanced measurement data processing and analysis techniques. Different demos are conducted, students will work in teams in their labs, on both simple experiments, and on one major experiment design. The course provides understanding of modern measurement techniques used to generate validation and verification data numerical models, and as such is expected to benefit the modelers as well. Relevant to mechanical, ocean, nuclear, civil, & numerical modeling grad.

Objectives & Outcomes

Course Objectives: Students will gain hand-on experience on several techniques, and become familiar (through theory and practice) with the strengths and limitations of various techniques.
The students will be trained in good experimental practices, introduced to modern techniques and approaches to data analysis.

Student Learning Outcomes: By the end of the course the students will be prepared to conduct leading edge experimental research work from design of the experiment through data analysis.
They will understand the fundamental principles of numerous measurement techniques, especially those relevant to fluids measurements.
This course will prepare students for graduate level experimental work, or its management, in academic or industrial labs.

Rules & Requirements

Prerequisites: Mechanical Engineering 103 or similar undergraduate introductory measurements class

Credit Restrictions: Students will receive no credit for MEC ENG 248 after completing MEC ENG 248. A deficient grade in MEC ENG 248 may be removed by taking MEC ENG 248.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Mäkiharju

MEC ENG 249 Machine Learning Tools for Modeling Energy Transport and Conversion Processes 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023

This course teaches students how machine learning tools work and their effective use in energy related research and technology development. This course first covers basic probability, linear algebra concepts, and foundation mathematics principles used in machine learning tools. Python programming will be used in class projects. Students will construct a genetic algorithm and a neural network model from scratch to explore basic features of these tools, and will then use Python neural network programming tools to develop models for energy conversion and energy transport process applications. Students will explore different machine learning methods in 3 assigned projects and can construct a final project in an application of interest to them.

Rules & Requirements

Prerequisites: Undergraduate courses in multivariable calculus and linear algebra Math 53 and Math 54 or equivalent), an undergraduate course in thermodynamics (MECENG 40, ENGIN 115 or equivalent), and an undergraduate course in computer programming (ENGIN 7 or COMPSCI 61A or equivalent)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Van Carey

MEC ENG 250A Advanced Conductive and Radiative Transport 3 Units

Terms offered: Spring 2025, Fall 2023, Fall 2022
Fundamentals of conductive heat transfer. Analytical and numerical methods for heat conduction in rigid media. Fundamentals of radiative transfer. Radiative properties of solids, liquids and gas media. Radiative transport modeling in enclosures and participating media.
Objectives & Outcomes

Course Objectives: The course will provide students with knowledge of the physics of conductive transport in solids, the analysis of steady and transient heat conduction by both analytical and numerical methods and the treatment of phase change problems. Furthermore, the course will provide students with knowledge of radiative properties, the mechanisms of radiative transfer and will present theory and methods of solution of radiative transfer problems in participating and nonparticipating media.

Student Learning Outcomes: Students will gain knowledge of the mechanisms of conductive transfer and will develop the ability to quantify steady and transient temperature in important engineering problems often encountered (e.g. manufacturing, materials processing, bio-thermal treatment and electronics cooling) by applying analytical methods and by constructing numerical algorithms. Students will also gain knowledge of the fundamental radiative properties and the mechanisms of radiative transport in enclosures, absorbing, emitting and scattering media as well as the interaction of thermal radiation with other modes of heat transfer.

Rules & Requirements

Prerequisites: Undergraduate courses in engineering thermodynamics, fluid dynamics and heat transfer (Mechanical Engineering 40, Mechanical Engineering 106 and Mechanical Engineering 109 or equivalent). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects

Credit Restrictions: Students will not be able to receive credit for this course if they have taken Mechanical Engineering 151, 151A or 251.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Grigoropoulos

MEC ENG 250B Advanced Convective Transport and Computational Methods 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2020
The transport of heat and mass in fluids in motion; free and forced convection in laminar and turbulent flow over surfaces and within ducts. Fundamentals of computational methods used for solving the governing transport equations will also be covered.
Objectives & Outcomes

Course Objectives: This course will provide students with knowledge of the physics of convective transport and an introduction to computational tools that can model convective processes in important applications such as electronics cooling, aerospace thermal management. The course also teaches students to construct computational models of natural and forced convection processes in boundary layers nears surfaces, in enclosures and in ducts or pipes that can be used to design heat exchangers and thermal management equipment for applications.

Student Learning Outcomes: Students will gain a knowledge of the mechanisms of convective heat and mass transfer for flow over surfaces and within ducts, and will develop the ability to construct computer programs that implement computation methods that predict the flow and temperature fields and heat transfer performance for convective flows of interest in engineering applications.

Rules & Requirements

Prerequisites: Undergraduate courses in engineering thermodynamics, fluid dynamics and heat transfer (Mechanical Engineering 40, Mechanical Engineering 106 and Mechanical Engineering 109 or equivalent). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects

Credit Restrictions: Students will not be able to receive credit for this course if they have taken Mechanical Engineering 252.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Carey

MEC ENG 251 Heat Conduction 3 Units

Terms offered: Spring 2018, Fall 2016, Fall 2015
Analytical and numerical methods for the determination of the conduction of heat in solids.

Rules & Requirements

Prerequisites: 151; Engineering 230A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 252 Heat Convection 3 Units

Terms offered: Spring 2017, Spring 2015, Spring 2014
The transport of heat in fluids in motion; free and forced convection in laminar and turbulent flow over surfaces and within ducts.

Rules & Requirements

Prerequisites: 151, 265A; Engineering 230A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Greif

MEC ENG 253 Graduate Applied Optics and Radiation 3 Units

Terms offered: Spring 2018, Fall 2015, Fall 2013
Fundamentals of electromagnetic theory, principles of optics, waves, diffraction theory, interference, geometrical optics, scattering, theory of molecular spectra, optical and spectroscopic instrumentation. Lasers and laser materials processing, laser spectroscopy. Modern optics, plasmonics.

Objectives & Outcomes

Course Objectives: The course will provide students with knowledge of the fundamental principles of optics to analyze optical phenomena and develop the background and skills to design optical instrumentation applied to engineering fields, including additive manufacturing, radiometry and spectroscopy.

Student Learning Outcomes: Students will gain knowledge of the EM theory, optical properties of materials, principles of spectroscopy for gases, liquids and solids, principles and applications of lasers and optical diagnostics. Students will develop the ability to design optical instrumentation systems in the context of key industrial applications, including additive manufacturing, materials processing, bio-optics, semiconductor industry applications, reacting systems, forensics.

Rules & Requirements

Prerequisites: Undergraduate courses in physics (e.g. 7A,B,C). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects

Credit Restrictions: Students will not receive credit for this course if they have taken ME 153.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Grigoropoulos

MEC ENG 254 Advanced Thermophysics for Applications 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Development of classical thermodynamics from statistical treatment of microscale molecular behavior; Boltzmann distribution; partition functions; statistical-mechanical evaluation of thermodynamic properties; equilibrium; chemical equilibrium; phase transitions; molecular collisions; Maxwell-Boltzmann distribution; collision theory; elementary kinetic theory; molecular dynamics simulation of molecular collisions; kinetic Monte Carlo simulations of gas-phase and gas-surface reactions. Implications are explored for a variety of applications, which may include advanced combustion systems, renewable power systems, microscale transport in high heat flux electronics cooling, aerospace thermal management, and advanced materials processing.
Objectives & Outcomes

Course Objectives: To introduce students to the statistical foundation of thermodynamics and provide skills to perform advanced calculations for analysis of advanced energy conversion processes and devices.

Student Learning Outcomes: Students ability to calculate partition functions, perform equilibrium calculations, and undertake molecular-dynamics and Monte-Carlo simulations of non-equilibrium systems.
This course will provide a foundation for design analysis of energy conversion systems and transport phenomena encountered in a variety of applications.

Rules & Requirements

Prerequisites: Mechanical Engineering 40

Credit Restrictions: Students will not receive credit for this course if they have taken ME 154.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Carey, Frenklach

MEC ENG 255 Advanced Combustion Processes 3 Units

Terms offered: Spring 2023, Fall 2020, Fall 2019
Fundamentals of combustion, flame structure, flame speed, flammability, ignition, stirred reaction, kinetics and nonequilibrium processes, pollutant formation. Application to engines, energy production, and fire safety.
Objectives & Outcomes

Course Objectives: The course provides an introduction to the subject of combustion, covering a broad range of topics important to the fields of energy conversion, engines, pollution and fires. It consists of classroom lectures and laboratory demonstration. It treats the fundamental processes occurring in combustion systems and emphasizes on technological-problem solving skills. The laboratory demonstrations provide practical experience with real combustion systems. The course also uses computer programs to aid the students in the calculations and analysis, especially in thermodynamics and chemical kinetics.

Student Learning Outcomes: Upon completion of the course, students shall be able to:
Understand and calculate the stoichiometry, adiabatic flame temperature and heat of combustion of a fuel and oxidizer mixture. Understand the role of elementary and global reactions. Calculate reaction rates. Know how to use computer codes (e.g. Cantera) to solve combustion problems. Understand and calculate the ignition characteristics of a fuel and oxidizer mixture: flammability limits, self-ignition. Understand and calculate the structure and properties of a premixed flame: propagation speed, thickness, quenching distance, and minimum ignition energy. Understand and calculate the structure and properties of a diffusion flame: height, lift-off distance and blow-off limit. Understand the formation of pollutants from hydrocarbon combustion. Understand the operation of practical systems, specifically, furnaces and boilers, spark ignition and diesel internal combustion engines, and gas turbines.

Rules & Requirements

Prerequisites: ME 40, ME 106, and ME 109 (or their equivalents)

Credit Restrictions: Students will receive no credit for this course if they have taken ME 140.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Chen, Fernandez-Pello

MEC ENG 256 Combustion 3 Units

Terms offered: Fall 2017, Spring 2015, Spring 2014
Combustion modeling. Multicomponent conservation equations with reactions. Laminar and turbulent deflagrations. Rankine-Hugoniot relations. Diffusion flames. Boundary layer combustion, ignition, and stability.

Objectives & Outcomes

Course Objectives: This course provides students a solid foundation in combustion sciences and technologies relevant to current and future energy conversion devices using combustion.

Student Learning Outcomes: Students will have the ability to perform critical analyses of current and future reacting systems using analytical and numerical methods. For practical combustion systems with complex geometries, students will have gained sufficient background to further their capabilities of using advanced numerical models.

Rules & Requirements

Prerequisites: ME 40, ME 106, and ME 109 (106 and 109 may be taken concurrently) or their equivalents. ME 140/ME255 is recommended

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Chen

MEC ENG 257 Advanced Combustion 3 Units

Terms offered: Fall 2016, Fall 2014, Fall 2012
Critical analyses of combustion phenomenon. Conservation relations applied to reacting systems. Reactions are treated by both asymptotic and numerical methods. Real hydrocarbon kinetics are used; where available reduced kinetic mechanics are introduced. Flame propagation theory and experiments are discussed in detail for both laminar and turbulent flows.

Rules & Requirements

Prerequisites: 256

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 258 Heat Transfer with Phase Change 3 Units

Terms offered: Spring 2024, Spring 2022, Fall 2018
Heat transfer associated with phase change processes. Topics include thermodynamics of phase change, evaporation, condensation, nucleation and bubble growth, two phase flow, convective boiling and condensation, melting and solidification.

Rules & Requirements

Prerequisites: 151

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Carey

MEC ENG 259 Microscale Thermophysics and Heat Transfer 3 Units

Terms offered: Fall 2020, Fall 2017, Spring 2016
This course introduces advanced statistical thermodynamics, nonequilibrium thermodynamics, and kinetic theory concepts used to analyze thermophysics of microscale systems and explores applications in which microscale transport plays an important role.

Rules & Requirements

Prerequisites: 151, 254, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Carey, Majumdar

MEC ENG 260A Advanced Fluid Mechanics I 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
Introduces the foundations of fluid mechanics. Exact flow solutions are used to develop a physical insight of the fluid flow phenomena. Rigorous derivation of the equations of motion. Incompressible and compressible potential flows. Canonical viscous flows.

Rules & Requirements

Prerequisites: 106; 185 (strongly recommended) or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 260B Advanced Fluid Mechanics II 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023
Develops a working knowledge of fluid mechanics by identifying the essential physical mechanism in complex canonical flow problems which leads to simplified yet accurate formulation. Boundary layers, creeping flows, rotational flows, rotating flows. Stability and transition, introduction to turbulence.

Rules & Requirements

Prerequisites: 260A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 262 Hydrodynamic Stability and Instability 3 Units

Terms offered: Fall 2021, Fall 2018, Fall 2014
Discussions of linear and nonlinear instabilities in a variety of fluid flows: thermal convection, Rayleigh-Taylor flows, shearing flows, circular and cylindrical Couette flows (i.e., centrifugal instability). Use of the Landau equation, bifurcation diagrams, and energy methods for nonlinear flows.

Rules & Requirements

Prerequisites: 185 and 106, or equivalents

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Marcus

MEC ENG 263 Turbulence 3 Units

Terms offered: Spring 2023, Spring 2019, Spring 2017
Physics of turbulence: Summary of stability and transition. Description of turbulence phenomena. Tools for studying turbulence. Homogeneous turbulence, shear turbulence, rotating turbulence. Summary of engineering models. Discussion of recent advances.

Rules & Requirements

Prerequisites: 260A-260B or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Savas

MEC ENG 263Z ENGINEERING AERODYNAMICS 3 Units

Terms offered: Fall 2025, Spring 2025, Fall 2022
Introduction to the lift, drag, and moment of two-dimensional airfoils, three-dimensional wings, and the complete airplane. Calculations of the performance and stability of airplanes in subsonic flight. The course is run on two loosely aligned parallel tracks: a traditional sequence of lectures covering the basic topics in aerodynamics and a set of projects on vortex dynamics and aerodynamics that are loosely aligned with lectures. The distinguishing factor will be the extend of the projects assigned to the graduate level participants, which will be substantially more involved than those expected from the senior level participants.

Rules & Requirements

Prerequisites: ME 40, ME 106

Credit Restrictions: Students will receive no credit for MEC ENG 263Z after completing MEC ENG 163. A deficient grade in MEC ENG 263Z may be removed by taking MEC ENG 163.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: SAVAS

MEC ENG 266 Geophysical and Astrophysical Fluid Dynamics 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2019
This course examines high-Reynolds number flows, including their stability, their waves, and the influence of rotating and stratification as applied to geophysical and astrophysical fluid dynamics as well as to engineering flows. Examples of problems studies include vortex dynamics in planetary atmospheres and protoplanetary disks, jet streams, and waves (Rossby, Poincare, inertial, internal gravity, and Kelvin) in the ocean and atmosphere.

Rules & Requirements

Prerequisites: Graduate-level standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Marcus

Formerly known as: 260C

MEC ENG C268 Physicochemical Hydrodynamics 3 Units

Terms offered: Spring 2017, Fall 2013, Fall 2011, Spring 2011
An introduction to the hydrodynamics of capillarity and wetting. Balance laws and short-range forces. Dimensionless numbers, scaling and lubrication approximation. Rayleigh instability. Marangoni effect. The moving contact line. Wetting and short-range forces. The dynamic contact angle. Dewetting. Coating flows. Effect of surfactants and electric fields. Wetting of rough or porous surfaces. Contact angles for evaporating systems.

Rules & Requirements

Prerequisites: A first graduate course in fluid mechanics sucs as 260A-260B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Morris

Also listed as: CHM ENG C268

MEC ENG 270 Advanced Augmentation of Human Dexterity 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
This course provides hands-on experience in designing prostheses and assistive technologies using user-centered design. Students will develop a fundamental understanding of the state-of-the-art, design processes and product realization. Teams will prototype a novel solution to a disabilities-related challenge, focusing on upper-limb mobility or dexterity. Lessons will cover biomechanics of human manipulation, tactile sensing and haptics, actuation and mechanism robustness, and control interfaces. Readings will be selected from texts and academic journals available through the UCB online library system and course notes. Guest speakers will be invited to address cutting edge breakthroughs relevant to assistive technology and design.
Objectives & Outcomes

Course Objectives: The course objectives are to:
- Learn the fundamental principles of biomechanics, dexterous manipulation, and electromechanical systems relevant for non-invasive, cutting-edge assistive device and prosthesis design
- Enhance skill in the areas of human-centered design, teamwork and communication through the practice of conducting labs and a project throughout the semester

Student Learning Outcomes: a knowledge of contemporary issues.
an ability to apply knowledge of mathematics, science, and engineering.
an ability to communicate effectively.
an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
an ability to identify, formulate, and solve engineering problems.
an understanding of professional and ethical responsibility.

Rules & Requirements

Prerequisites: MECENG 132, or equivalent. Proficiency with Matlab or equivalent programming language

Credit Restrictions: Students will receive no credit for MEC ENG 270 after completing MEC ENG 179.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Stuart

MEC ENG 271 Intermediate Dynamics 3 Units

Terms offered: Fall 2024, Spring 2023, Spring 2022
This course introduces and investigates Lagrange's equations of motion for particles and rigid bodies. The subject matter is particularly relevant to applications comprised of interconnected and constrained discrete mechanical components. The material is illustrated with numerous examples. These range from one-dimensional motion of a single particle to three-dimensional motions of rigid bodies and systems of rigid bodies.
Objectives & Outcomes

Course Objectives: Introduce students to the notion of exploiting differential geometry to gain insight into the dynamics of a mechanical system. Familiarize the student with classifications and applications of generalized forces and kinematical constraints. Enable the student to establish Lagrange's equations of motion for a single particle, a system of particles and a single rigid body. Establish equivalence of equations of motion using the Lagrange and Newton-Euler approaches. Discuss the developments of analytical mechanics drawing from applications in navigation, vehicle dynamics, toys, gyroscopes, celestial mechanics, satellite dynamics and computer animation.

Rules & Requirements

Prerequisites: ME 104 or equivalent

Credit Restrictions: Students will receive no credit for MEC ENG 271 after completing MEC ENG 175, or MEC ENG 271. A deficient grade in MEC ENG 271 may be removed by taking MEC ENG 271.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: O'Reilly, Casey

MEC ENG 272 Wildland Fires: Science and Applications 3 Units

Terms offered: Fall 2024, Spring 2022
This course presents an introduction to the global problem of wildland fires with an overview of the social, political and environmental issues posed as well as detailed coverage of the science, technology and applications used to predict, prevent and suppress wildland fires. Some specific topics covered will include fire spread theory, risk mapping, research instrumentation, suppression, ignition sources, relevant codes and standards, remote sensing, smoke management, and extreme fire behavior. Engineering analyses in many of these areas, as well as specific coverage of fire protection design in the Wildland-Urban Interface (WUI) will also be covered.
Objectives & Outcomes

Course Objectives: The course objectives are to provide students with the knowledge necessary to work within the highly interdisciplinary field of wildland fire, including a broad understanding of the social, ecological, and economic factors influencing wildland fire, a firm understanding of the underlying mechanisms affecting wildland fire processes, and an ability to apply the tools necessary to predict the spread rate and intensity of wildland fires and assess protection of WUI communities.

Student Learning Outcomes: (a) An ability to apply knowledge of mathematics, science, and engineering.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, formulate, and solve engineering problems.
(f) An understanding of professional and ethical responsibility.
(g) An ability to communicate effectively.
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
(i) A recognition of the need for, and an ability to engage in life-long learning.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements

Prerequisites: MEC ENG 109 or equivalent course in heat transfer (concurrent enrollment allowed)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Gollner

MEC ENG 273 Oscillations in Linear Systems 3 Units

Terms offered: Spring 2025, Spring 2023, Spring 2022
Response of discrete and continuous dynamical systems, damped and undamped, to harmonic and general time-dependent loading. Convolution integrals and Fourier and Laplace transform methods. Lagrange’s equations; eigensolutions; orthogonality; generalized coordinates; nonreciprocal and degenerate systems; Rayleigh’s quotient.
Objectives & Outcomes

Course Objectives: To give a compact, consistent, and reasonably connected account of the theory of linear vibration at the advanced level. A secondary purpose is to survey some topics of contemporary research. Applications will be mentioned whenever feasible.

Student Learning Outcomes: Acquired necessary knowledge and scientific maturity to begin research in dynamics and vibration.

Rules & Requirements

Prerequisites: ME 104 and ME 133 or their equivalents

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Ma

MEC ENG 274 Random Oscillations of Mechanical Systems 3 Units

Terms offered: Spring 2018, Spring 2015, Spring 2011
Random variables and random processes. Stationary, nonstationary, and ergodic proceses. Analysis of linear and nonlinear, discrete and continuous, mechanical systems under stationary and nonstationary excitations. Vehicle dynamics. Applications to failure analysis. Stochastic estimation and control and their applications to vibratory systems.
Rules & Requirements

Prerequisites: 104 and 133

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Ma

MEC ENG 275 Advanced Dynamics 3 Units

Terms offered: Spring 2017, Spring 2015, Spring 2012
Review of Lagrangian dynamics. Legendre transform and Hamilton's equations, Cyclic coordinates, Canonical transformations, Hamilton-Jacobi theory, integrability. Dynamics of asymmetric systems. Approximation theory. Current topics in analytical dynamics.

Rules & Requirements

Prerequisites: 175

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 276DS Statistics and Data Science for Engineers 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024
This course provides a foundation in data science with emphasis on the application of statistics and machine learning to engineering problems. The course combines theoretical topics in probability and statistical inference with practical methods for solving problems in code. Each topic is demonstrated with examples from engineering. These include hypothesis testing, principal component analysis, clustering, linear regression, time series analysis, classification, and deep learning. Math 53 and 54 are recommended before Engin 178, Math 53 and 54 are allowed concurrently.

Objectives & Outcomes

Course Objectives: To demonstrate the use of data science in engineering tasks.

To enable students to import, clean, visualize, and interpret data sets using modern computer languages.
To familiarize students with a range of techniques for building models from data.
To introduce the concepts of quantitative statistics and probability.
To provide a theoretical and conceptual basis for students to understand the role of data in engineering.

To teach students how to build and train machine learning models.

Student Learning Outcomes: A knowledge of contemporary issues.
An ability to apply knowledge of mathematics, science, and engineering.

An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
An ability to design and conduct experiments, as well as to analyze and interpret data.

An ability to identify, formulate, and solve engineering problems
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

Rules & Requirements

Prerequisites: ENGIN 7 or equivalent, MATH 51, MATH 52, MATH 53; and MATH 54 (may be taken concurrently)

Credit Restrictions: Students will receive no credit for ENGIN 278 after completing ENGIN 178. A deficient grade in ENGIN 278 may be removed by taking ENGIN 178, or ENGIN 178.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Gomes,Gabriel, Horowitz, Roberto

Formerly known as: Engineering 278

MEC ENG 277 Nonlinear and Random Vibrations 3 Units

Terms offered: Spring 2021, Spring 2016, Spring 2014
Oscillations in nonlinear systems having one or two degrees of freedom. Graphical, iteration, perturbation, and asymptotic methods. Self-excited oscillations and limit cycles. Random variables and random processes. Analysis of linear and nonlinear, discrete and continuous, mechanical systems under stationary and non-stationary excitations.

Objectives & Outcomes

Course Objectives: To give a compact, consistent, and reasonably connected account of the theory of nonlinear vibrations and uncertainty analysis at the advanced level. A secondary purpose is to survey some topics of contemporary research.

Student Learning Outcomes: Acquired necessary knowledge and scientific maturity to begin research in nonlinear vibrations and uncertainty analysis.

Rules & Requirements

Prerequisites: Mechanical Engineering 104 and Mechanical Engineering 133 or their equivalent

Credit Restrictions: Students will not receive credit if they have taken Mechanical Engineering 274.

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Ma

MEC ENG C278 Adv Designing for the Human Body 4 Units

Terms offered: Fall 2025, Fall 2024, Fall 2019, Fall 2018
The course provides project-based learning experience in understanding product design, with a focus on the human body as a mechanical machine. Students will learn the design of external devices used to aid or protect the body. Topics will include forces acting on internal materials (e.g., muscles and total replacement devices), forces acting on external materials (e.g., prothetics and crash pads), design/analysis of devices aimed to improve or fix the human body, muscle adaptation, and soft tissue injury. Weekly laboratory projects will incorporate EMG sensing, force plate analysis, and interpretation of data collection (e.g., MATLAB analysis) to integrate course material to better understand contemporary design/analysis/problems.

Objectives & Outcomes

Course Objectives: The purpose of this course is twofold:

- to learn the fundamental concepts of designing devices that interact with the human body;
- to enhance skills in mechanical engineering and bioengineering by analyzing the behavior of various complex biomedical problems;
- To explore the transition of a device or discovery as it goes from “benchtop to bedside”.
- Three separate written projects evaluating devices that interact with the body. Projects will focus on 1) biomechanical analysis, 2) FDA regulations and procedures, and 3) design lifecycle.

Student Learning Outcomes: Working knowledge of design considerations for creating a device to protect or aid the human body, force transfer and distribution, data analysis, and FDA approval process for new devices. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved. Critical analysis of current literature and technology.

Rules & Requirements

Prerequisites: Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Credit Restrictions: There will be no credit given for MEC ENG C178 / BIO ENG C137 after taking MEC ENG 178.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: O'Connell

Also listed as: BIO ENG C237

MEC ENG C279 Introduction to Statistical Mechanics for Engineers 3 Units

Terms offered: Spring 2025, Spring 2020, Spring 2017
Introduction to statistical mechanics for engineers. Basics of ensembles, phase spaces, partitions functions, and free energies. Analysis of expectation values and fluctuations in system properties. Applications to the study of elementary gases, phonons in solids, polymer chains and networks, harmonic and quasi-harmonic crystalline solids; limitations of classical methods and quantum mechanical influences; molecular dynamics simulations for solids.

Objectives & Outcomes

Course Objectives: To provide a modern introduction to the application of statistical mechanics for engineering with a particular emphasis on mechanical response.

Rules & Requirements

Prerequisites: CE C231 or MSE C211 or ME 185 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Govindjee, Papadopoulos

Also listed as: CIV ENG C235

MEC ENG 280A Introduction to the Finite Element Method 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Weighted-residual and variational methods of approximation. Canonical construction of finite element spaces. Formulation of element and global state equations. Applications to linear partial differential equations of interest in engineering and applied science.

Rules & Requirements

Prerequisites: Mathematics 50A-50B; some familiarity with elementary field theories of solid/fluid mechanics and/or thermal science

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Papadopoulos, Zohdi

Formerly known as: 280

MEC ENG 280B Finite Element Methods in Nonlinear Continua 3 Units

Terms offered: Spring 2025, Spring 2022, Spring 2019
A brief review of continuum mechanics. Consistent linearization of kinematical variables and balance laws. Incremental formulations of the equations of motion. Solution of the nonlinear field equations by Newton's method and its variants. General treatment of constraints. Applications to nonlinear material and kinematical modeling on continua.

Rules & Requirements

Prerequisites: 280A or equivalent; background in continuum mechanics at the level of 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Papadopoulos

MEC ENG 281 Methods of Tensor Calculus and Differential Geometry 3 Units

Terms offered: Fall 2021, Fall 2017, Fall 2015
Methods of tensor calculus and classical differential geometry. The tensor concept and the calculus of tensors, the Riemann-Christoffel tensor and its properties, Riemannian and Euclidean spaces. Geometry of a surface, formulas of Weingarten, and equations of Gauss and Codazzi.

Rules & Requirements

Prerequisites: Mathematics 53 and 54

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 282 Theory of Elasticity 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020
Fundamentals and general theorems of the linear theory of elasticity (in three dimensions) and the formulation of static and dynamic boundary value problems. Application to torsion, flexure, and two-dimensional problems of plane strain, generalized plane stress, and bending of plates. Representation of basic field equations in terms of displacement potentials and stress functions. Some basic three-dimensional solutions.
Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Bogy, Steigmann

MEC ENG 283 Wave Propagation in Elastic Media 3 Units

Terms offered: Fall 2013, Fall 2012, Fall 2009
Propagation of mechanical disturbances in unbounded and bounded media. Surface waves, wave reflection and transmission at interfaces and boundaries. Stress waves due to periodic and transient sources. Some additional topics may vary with instructor.
Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Bogy

MEC ENG 284 Nonlinear Theory of Elasticity 3 Units

Terms offered: Fall 2025, Spring 2023, Spring 2019
Fundamentals of the nonlinear theory of elasticity. Material symmetry. Exact solutions in elastostatics. Internal constraints. Useful strain-energy functions. Uniqueness. Compatibility conditions. Volterra dislocations. The Eshelby tensor. Small deformations superposed on finite deformations. Waves in pre-stressed solids. Stability. Bifurcations and buckling. Acceleration waves. Entropic elasticity.
Objectives & Outcomes

Course Objectives: To provide students with a working knowledge of elasticity.

Student Learning Outcomes: Ability to embark on modern research in the field.

Rules & Requirements

Prerequisites: ME 185 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Casey

MEC ENG 285A Foundations of the Theory of Continuous Media 3 Units

Terms offered: Spring 2023, Spring 2020, Spring 2018
A general development of thermodynamics of deformable media, entropy production, and related entropy inequalities. Thermomechanical response of dissipative media, including those for viscous fluids and nonlinear elastic solids. A discussion of invariance, internal constraints, material symmetry, and other special topics.
Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Casey

Formerly known as: 285

MEC ENG 285B Surfaces of Discontinuity and Inhomogeneities in Deformable Continua 3 Units

Terms offered: Fall 2011, Spring 2010, Fall 2008
Finitely deforming thermo-mechanical media. Moving surfaces of discontinuity. Shock waves and acceleration waves in elastic materials. The Eshelby tensor and Eshelbian mechanics. Fracture. Microstructured continua.

Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Casey

MEC ENG 285C Electrodynamics of Continuous Media 3 Units

Terms offered: Spring 2023, Spring 2019, Spring 2015
This course presents the fundamentals of electromagnetic interactions in deformable continuous media. It develops the background necessary to understand various modern technologies involving MEMS devices, sensors and actuators, plasmas, and a wide range of additional phenomena. The emphasis of this course is on fundamentals, beginning with Maxwell's equations in vacuum, the ether relations and their extension to electromagnetic interactions in materials. The treatment is general within the limits of nonrelativistic physics and accommodates coupling with mechanical and thermal effects. The topics discussed are all developed at a general level including the effects of finite deformations. Various linear models, which are especially useful in applications, are developed through specialization of general theory. This course will be of interest to students in engineering, physics, and applied mathematics.

Rules & Requirements

Prerequisites: A first course in continuum mechanics (such as 185 or Civil Engineering 231.)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Steigmann

Formerly known as: 284B

MEC ENG 285D Engineering Rheology 3 Units

Terms offered: Spring 2016, Spring 2014
Rheology is the study of the interaction between forces and the flow/deformation of materials. It deals with aspects of the mechanics of materials that are not covered in the standard curriculum, such as the response of viscoelastic fluids and solids, together with methods for modeling and simulating their response. Such materials exhibit a host of counterintuitive phenomena that call for nonlinear modeling and a close interaction between theory and experiment. This is a special-topics course for graduate students seeking advanced knowledge of these phenomena and associated modeling.

Objectives & Outcomes

Course Objectives: To expose students to the theory and methods of modern rheology, including: the mechanics of flow in complex non-Newtonian fluids and the mechanics of viscoelastic solids.

Student Learning Outcomes: Skill in modeling and simulating rheological problems.

Rules & Requirements

Prerequisites: A basic background in continuum mechanics (as covered in ME 185)

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Steigmann

MEC ENG C285E Mechanics and Physics of Lipid Bilayers 3 Units

Terms offered: Fall 2017
Lipid bilayers constitute the membrane that encloses every animal cell and many of its interior structures, including the nuclear envelope, the organelles and the endoplasmic reticulum. This is a unique course devoted to modern developments in this exceptionally active field of research, ranging from models based on continuum theory to recent developments based on statistical mechanics.
Objectives & Outcomes

Student Learning Outcomes: To expose students to advanced current work on the mechanics and physics of lipid bilayers (a very active field of current research relevant to biomechanics and biophysics)

Rules & Requirements

Prerequisites: Mechanical Engineering 185 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Steigmann

Also listed as: CHM ENG C294A

MEC ENG 286 Theory of Plasticity 3 Units

Terms offered: Fall 2024, Fall 2020, Fall 2018
Formulation of the theory of plasticity relative to loading surfaces in both strain space and stress space and associated loading criteria. Nonlinear constitutive equations for finitely deformed elastic-plastic materials. Discussion of strain-hardening and special cases. Applications.
Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Casey, Papadopoulos

MEC ENG 287 Graduate Introduction to Continuum Mechanics 3 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
This course is a general introduction to the fundamental concepts of the mechanics of continuous media. Topics covered include the kinematics of deformation, the concept of stress, and the conservation laws for mass, momentum and energy. This is followed by an introduction to constitutive theory with applications to well-established models for viscous fluids and elastic solids. The concepts are illustrated through the solution of tractable initial-boundary-value problems. This course presents foundation-level coverage of theory underlying a number of sub-fields, including Fluid Mechanics, Solid Mechanics and Heat Transfer.
Objectives & Outcomes

Course Objectives: This is a gateway course for graduate students entering the fields of Solid Mechanics and Fluid Mechanics. It is designed for students who require a rigorous foundation-level understanding in support of their future work in the theory, modeling and analysis of problems arising in the Engineering Sciences.

Student Learning Outcomes: Students will gain a deep understanding of the concepts and methods underlying modern continuum mechanics. The course is designed to equip students with the background needed to pursue advanced graduate work in allied fields.

Rules & Requirements

Prerequisites: Physics 7A, Math 53 and Math 54, as well as some prior exposure to the elementary mechanics of solids and fluids

Credit Restrictions: Students will receive no credit after taking ME 185.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Casey, Johnson, Papadopoulos, Steigmann

MEC ENG 288 Theory of Elastic Stability 3 Units

Terms offered: Spring 2009, Fall 2007, Fall 1999
Dynamic stability of elastic bodies. Small motion on finite deformation. Classical treatments of buckling problems. Snapthrough and other global stability problems. Stability theory based upon nonlinear three-dimensional theory of elasticity.
Rules & Requirements

Prerequisites: 185 and 273

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Steigmann

MEC ENG 289 Theory of Shells 3 Units

Terms offered: Spring 2024, Spring 2017, Spring 2012
A direct formulation of a general theory of shells and plates based on the concept of Cosserat (or Directed) surfaces. Nonlinear constitutive equations for finitely deformed elastic shells. Linear theory and a special nonlinear theory with small strain accompanied by large or moderately large rotation. Applications.
Rules & Requirements

Prerequisites: 185 and 281

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Johnson, Steigmann

MEC ENG 290C Topics in Fluid Mechanics 3 Units

Terms offered: Fall 2024, Spring 2020, Spring 2015
Lectures on special topics which will be announced at the beginning of each semester that the course is offered. Topics may include transport and mixing, geophysical fluid dynamics, biofluid dynamics, oceanography, free surface flows, non-Newtonian fluid mechanics, among other possibilities.
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Savas, Yeung

MEC ENG 290D Solid Modeling and CAD/CAM Fundamentals 3 Units

Terms offered: Spring 2024, Spring 2022, Fall 2018
Graduate survey of solid modeling research. Representations and algorithms for 3D solid geometry. Applications in design, analysis, planning, and manufacturing of mechanical parts, including CAD/CAM, reverse engineering, robotics, mold-making, and rapid prototyping.
Objectives & Outcomes

Course Objectives: Students will gain experience with critical close reading of primary sources, evaluating and synthesizing the content of research papers. They will design, implement, and analyze a sample of geometric algorithms for applications in Solid Modeling and CAD/CAM.

Student Learning Outcomes: Students will be familiar with seminal research and important solid modeling representations and fundamental geometric algorithms, giving them insight into the capabilities and limitations of commercial solid modeling systems. They will have gained programming experience and skills and an understanding of theoretical and practical concerns as they design, implement, and analyze a sample of geometric algorithms for applications in Solid Modeling and CAD/CAM.

Rules & Requirements

Prerequisites: An introductory programming course; graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: McMains

MEC ENG 290G Laser Processing and Diagnostics 3 Units

Terms offered: Fall 2024, Spring 2023, Spring 2021
The course provides a detailed account of laser interactions with materials in the context of advanced materials processing and diagnostics.
Rules & Requirements

Prerequisites: Graduate standing or undergraduate elective upon completion of ME109

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Grigoropoulos

MEC ENG 290H Green Product Development: Design for Sustainability 3 Units

Terms offered: Spring 2022, Spring 2019, Spring 2017
The focus of the course is management of innovation processes for sustainable products, from product definition to sustainable manufacturing and financial models. Using a project in which students will be asked to design and develop a product or service focused on sustainability, we will teach processes for collecting customer and user needs data, prioritizing that data, developing a product specification, sketching and building product prototypes, and interacting with the customer/community during product development. The course is intended as a very hands-on experience in the "green" product development process. The course will be a Management of Technology course offered jointly with the College of Engineering and the Haas School of Business. In addition, it will also receive credit towards the new Certificate on Engineering Sustainability and Environmental Management program. We aim to have half MBA students and half Engineering students (with a few other students, such as from the School of Information) in the class. The instructors will facilitate students to form mixed disciplinary reams for the development of their "green" products.
Rules & Requirements

Prerequisites: Graduate standing in Engineering or Information, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Agogino, Beckmann

MEC ENG 290I Sustainable Manufacturing 3 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014
Sustainable design, manufacturing, and management as exercised by the enterprise is a poorly understood idea and one that is not intuitively connected to business value or engineering practice. This is especially true for the manufacturing aspects of most enterprises (tools, processes, and systems). This course will provide the basis for understanding (1) what comprises sustainable practices in for-profit enterprises, (2) how to practice and measure continuous improvement using sustainability thinking, techniques, and tools for product and manufacturing process design, and (3) the techniques for and value of effective communication of sustainablilty performance to internal and external audiences. Material in the course will be supplemented by speakers with diverse backgrounds in corporate sustainability, environmental consulting, non-governmental organizations, and academia.
Rules & Requirements

Prerequisites: Graduate standing, or consent of instructor, especially for students not in engineering, business, or other management of technology programs

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Dornfeld

MEC ENG 290J Predictive Control for Linear and Hybrid Systems 3 Units

Terms offered: Spring 2016, Fall 2014, Spring 2013
Advanced optimization, polyhedra manipulation, and multiparametric programming. Invariant set theory. Analysis and design of constrained predictive controllers for linear and nonlinear systems. Computational oriented models of hybrid systems. Analysis and design of constrained predictive controllers for hybrid systems.

Objectives & Outcomes

Course Objectives: The course is designed for graduate students who want to expand their knowledge on optimization-based control design. 50% will be focusing on advanced theory. 50% on applications.

Student Learning Outcomes: At the end of the course, the students will write a theoretical paper on MPC and will design an experiment where the theory is implemented.

Rules & Requirements

Prerequisites: ME C232 and ME C231A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Borrelli

MEC ENG 290KA Innovation through Design Thinking 2 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Designed for professionally-oriented graduate students, this course explores key concepts in design innovation based on the human-centered design approach called “design thinking.” Topics covered include human-centered design research, analysis of research to develop design principles, creativity techniques, user needs framing and strategic business modeling.

Objectives & Outcomes

Student Learning Outcomes: The primary goal is to provide students with a set of innovation skills that will allow them to flourish in a climate of complex problem solving and design challenges. Students will develop expertise in innovation skills drawn from the fields of critical thinking, design thinking and systems thinking. Students should be able to apply the skills mastered to real world design problems.

Rules & Requirements

Prerequisites: Graduate level standing; Prior design course

Hours & Format

Fall and/or spring: 8 weeks - 4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Agogino

MEC ENG 290KB Life Cycle Thinking in Engineering Design 1 Unit

Terms offered: Fall 2017, Fall 2016, Fall 2015
How do we design and manufacture greener products, and how do we know if they really are? This class both provides tools for sustainable design innovation and metrics to measure success. Students will use both creative and analytical skills, generating new ideas as well as evaluating designs with screening-level life cycle assessment.
Objectives & Outcomes

Course Objectives: The objective of this course is to provide students with the tools to frame, analyze, and redesign their projects in terms of life cycle environmental impacts, to improve the sustainability of their projects.

Student Learning Outcomes: Students can expect to depart the course understanding the practice of basic life cycle assessment, including how to set boundaries, choose functional units, and use LCA software. Students will also learn how to integrate this practice into new product development in the context of the “triple bottom line” – economy, environment and society. Students should be able to apply the skills mastered to real world design and engineering problems.

Rules & Requirements

Prerequisites: Graduate level standing; Prior design course

Hours & Format

Fall and/or spring: 8 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Agogino

MEC ENG 290L Introduction to Nano-Biology 3 Units

Terms offered: Fall 2020, Fall 2018, Spring 2017
This course introduces graduate students in Mechanical Engineering to the nascent field of Nano-Biology. The course is comprised of both formal lectures and projects. Lectures will include an introduction to both molecular biology (components of cells, protein structure and function, DNA, gene regulation, etc.) and nanotechnology ("bottom up" and "top down" nanotechnologies), an overview of current instrumentation in biology, an in-depth description of the recent integration of molecular biology with nanotechnology (for sensing or labeling purposes, elucidating information on cells, etc.), and an introduction to Systems Biology (design principles of biological circuits).
Objectives & Outcomes

Course Objectives: The course introduces engineering students to the interplay between Nanotechnology and Biology and serves to 1) broaden the areas of research that students might not have necessarily considered, 2) expose students to cutting-edge research, and 3) develop analytical skills.

Student Learning Outcomes: Students should be able to critique methods and techniques that researchers have used to study and probe biological systems at the nano-scale. They will learn how to write research proposals and how to give an effective presentation. Through the research proposals, students will learn about the scientific-research process: formulating the problem, determining the appropriate experimental methods, interpreting the results, and arriving at a conclusion. Through presentations, students will gain valuable experience in public speaking and learn the process by which they would have to propose a research problem, be it in academia or industry.

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Sohn

MEC ENG 290M Expert Systems in Mechanical Engineering 3 Units

Terms offered: Fall 2005, Fall 2003, Spring 1999
Introduction to artificial intelligence and decision analysis in mechanical engineering. Fundamentals of analytic design, probability theory, failure analysis, risk assessment, and Bayesian and logical inference. Applications to expert systems in probabilistic mechanical engineering design and failure diagnostics. Use of automated influence diagrams to codify expert knowledge and to evaluate optimal design decisions.
Rules & Requirements

Prerequisites: 102A and 102B or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Agogino

MEC ENG 290N System Identification 3 Units

Terms offered: Spring 2020, Fall 2010, Fall 2008
This course is intended to provide a comprehensive treatment of both classical system identification and recent work in control-oriented system identification. Numerical, practical, and theoretical aspects will be covered. Topics treated include time and frequency domain methods, generalized parameter estimation, identification of structured non-linear systems, modeling uncertainty bounding, and state-space methods.
Rules & Requirements

Prerequisites: 232, Electrical Engineering and Computer Sciences 221A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Poolla

MEC ENG 290P New Product Development: Design Theory and Methods 3 Units

Terms offered: Fall 2015, Fall 2013, Fall 2012
This course is aimed at developing the interdisciplinary skills required for successful product development in today's competitive marketplace. We expect students to be disciplinary experts in their own field (e.g., engineering, business). By bringing together multiple perspectives, we will learn how product development teams can focus their efforts to quickly create cost-effective products that exceed customers' expectations.
Objectives & Outcomes

Course Objectives: Students can expect to depart the semester understanding new product development processes as well as useful tools, techniques and organizational structures that support new product development practice.

Student Learning Outcomes: Students can expect to depart the semester understanding new product development processes as well as useful tools, techniques and organizational structures that support new product development practice in the context of the “triple bottom line” – economy, environment and society.

Rules & Requirements

Prerequisites: Graduate standing, consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of voluntary per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Agogino

MEC ENG 290Q Dynamic Control of Robotic Manipulators 3 Units

Terms offered: Fall 2008, Spring 2007, Fall 2001
Dynamic and kinematic analysis of robotic manipulators. Sensors (position, velocity, force and vision). Actuators and power transmission lines. Direct drive and indirect drive. Point to point control. Straight and curved path following. Industrial practice in servo control. Applications of optimal linear quadratic control, preview control, nonlinear control, and direct/indirect adaptive controls. Force control and compliance control. Collision avoidance. Utilization of dynamic controls
Rules & Requirements

Prerequisites: 230, 232, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Horowitz, Kazerooni

MEC ENG 290R Topics in Manufacturing 3 Units

Terms offered: Spring 2025, Fall 2017, Spring 2016
Advanced topics in manufacturing research. Topics vary from year to year.

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Dornfeld, McMains, Wright

MEC ENG 290T Plasmonic Materials 3 Units

Terms offered: Fall 2017, Fall 2014, Spring 2013
This course deals with fundamental aspects of plasmonic materials. The electromagnetic responses of those artificially constructed materials will be discussed. Physics of surface plasmons and dispersion engineering will be introduced. Resonant phenomena associated with the negative permittivity and permeability and the left-handed propagation will be presented. Methods of design, fabrication, and characterization of plasmonic materials will be discussed.

Rules & Requirements

Prerequisites: Physics 110A or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Zhang

MEC ENG 290U Interactive Device Design 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
This course teaches concepts and skills required to design, prototype, and fabricate interactive devices -- that is, physical objects that intelligently respond to user input and enable new types of interactions.

Objectives & Outcomes

Course Objectives: To educate students in the hybrid design skills needed for today's electronic products. These combine mechanical devices, electronics, software, sensors, wireless communication and connections to the cloud. Students also learn scale up procedures for volume manufacturing.

Student Learning Outcomes: 3D printed prototypes, learned software, programming and design skills

Rules & Requirements

Prerequisites: Instructor consent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructors: Hartmann, Wright

MEC ENG 290V Topics in Energy, Climate, and Sustainability 1 Unit

Terms offered: Prior to 2007
Weekly lecture series featuring guest speakers from academia, industry, government, and civil society. Speakers will address cutting-edge topics involving novel technologies in energy and climate; the production, consumption, and economic exchange of energy resources and commodities; and energy and climate policy. Undergraduate and graduate students welcome.
Objectives & Outcomes

Course Objectives: Introduce UC Berkeley students to a variety of perspectives from stakeholders working on the science, technology, economics, and policy of energy and climate issues.

Student Learning Outcomes: Introduce students to interdisciplinary perspectives on energy and climate issues; attract top speakers to campus from academia, industry, government, and civil society; and build community at UC Berkeley around interdisciplinary energy and climate issues.

Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: Wright, Burns, Cullenward

MEC ENG C290S Hybrid Systems and Intelligent Control 3 Units

Terms offered: Spring 2021, Spring 2020, Spring 2018
Analysis of hybrid systems formed by the interaction of continuous time dynamics and discrete-event controllers. Discrete-event systems models and language descriptions. Finite-state machines and automata. Model verification and control of hybrid systems. Signal-to-symbol conversion and logic controllers. Adaptive, neural, and fuzzy-control systems. Applications to robotics and Intelligent Vehicle and Highway Systems (IVHS).
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 291E

Also listed as: EL ENG C291E

MEC ENG C290X Advanced Technical Communication: Proposals, Patents, and Presentations 3 Units

Terms offered: Spring 2018, Spring 2016, Spring 2012, Spring 2011
This course will help the advanced Ph.D. student further develop critically important technical communication traits via a series of lectures, interactive workshops, and student projects that will address the structure and creation of effective research papers, technical reports, patents, proposals, business plans, and oral presentations. One key concept will be the emphasis on focus and clarity--achieved through critical thinking regarding objectives and context. Examples will be drawn primarily from health care and bioengineering multidisciplinary applications.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: Keaveny, Pruitt

Also listed as: BIO ENG C290D

MEC ENG 292A Advanced Special Topics in Bioengineering 1 - 4 Units

Terms offered: Spring 2025, Spring 2022, Fall 2020
This 292 series covers current topics of research interest in bioengineering and biomechanics. The course content may vary semester to semester. Check with the department for current term topics.
Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

Instructor: Faculty

MEC ENG 292B Advanced Special Topics in Controls 1 - 4 Units

Terms offered: Fall 2025, Fall 2024, Spring 2024
This series covers current topics of research interest in controls. The course content may vary semester to semester. Check with the department for current term topics.

Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292C Advanced Special Topics in Design 1 - 4 Units

Terms offered: Fall 2025, Spring 2025, Spring 2024
This series covers current topics of research interest in design. The course content may vary semester to semester. Check with the department for current term topics.

Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292D Advanced Special Topics in Dynamics 1 - 4 Units

Terms offered: Prior to 2007
This series covers current topics of research interest in dynamics. The course content may vary semester to semester. Check with the department for current term topics.

Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292E Advanced Special Topics in Energy Science and Technology 1 - 4 Units

Terms offered: Spring 2024, Fall 2023, Fall 2019
This 292 series covers current topics of research interest in energy science and technology. The course content may vary semester to semester. Check with the department for current term topics.

Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292F Advanced Special Topics in Fluids 1 - 4 Units

Terms offered: Prior to 2007
This 292 series covers current topics of research interest in fluids. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292G Advanced Special Topics in Manufacturing 1 - 4 Units

Terms offered: Prior to 2007
This 292 series covers current topics of research interest in manufacturing. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292H Advanced Special Topics in Materials 1 - 4 Units

Terms offered: Prior to 2007
This 292 series covers current topics of research interest in materials. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292I Advanced Special Topics in Mechanics 1 - 4 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024
This series covers current topics of research interest in mechanics. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292J Advanced Special Topics in MEMS/Nano 1 - 4 Units

Terms offered: Spring 2018
This 292 series covers current topics of research interest in MEMS/nano. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 292K Advanced Special Topics in Ocean Engineering 1 - 4 Units

Terms offered: Spring 2025, Fall 2023, Fall 2022
This series covers current topics of research interest in ocean engineering. The course content may vary semester to semester. Check with the department for current term topics.
Objectives & Outcomes

Course Objectives: Varies with course.

Student Learning Outcomes: Varies with course.

Rules & Requirements

Prerequisites: Graduate student standing or consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Letter grade.

MEC ENG 297 Engineering Field Studies 1 - 12 Units

Terms offered: Spring 2025, Spring 2024, Summer 2023 First 6 Week Session
Supervised experience relative to specific aspects of practice in engineering. Under guidance of a faculty member, the student will work in an internship in industry. Emphasis is to attain practical experience in the field.
Hours & Format

Fall and/or spring: 15 weeks - 1-12 hours of independent study per week

Summer:
6 weeks - 2.5-20 hours of independent study per week
10 weeks - 1.5-18 hours of independent study per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

MEC ENG 298 Group Studies, Seminars, or Group Research 1 - 8 Units

Terms offered: Fall 2025, Spring 2025, Fall 2024
Advanced studies in various subjects through special seminars on topics to be selected each year. Informal group studies of special problems, group participation in comprehensive design problems, or group research on complete problems for analysis and experimentation.
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-8 hours of independent study per week

Summer: 10 weeks - 1.5-12 hours of independent study per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

MEC ENG 299 Individual Study or Research 1 - 12 Units

Terms offered: Fall 2025, Summer 2025 10 Week Session, Spring 2025
Investigations of advanced problems in mechanical engineering.

Rules & Requirements

Prerequisites: Graduate standing in engineering, physics, or mathematics

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-12 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Mechanical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

MEC ENG 375 Teaching of Mechanical Engineering at the University Level 1 - 6 Units

Terms offered: Fall 2025, Fall 2024, Fall 2023
Weekly seminars and discussions on effective teaching methods. Educational objectives. Theories of learning. The lecture and alternative approaches. Use of media resources. Student evaluation. Laboratory instruction. Curricula in mechanical engineering. Practice teaching. This course is open to Teaching Assistants of Mechanical Engineering.

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Mechanical Engineering/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Mechanical Engineering 301