# Mechanical Engineering

College of Engineering and Computer Science

**Chair: Hamid Johari**
**Jacaranda Hall (JD) 4513**
**(818) 677-2187**
**www.ecs.csun.edu/me/**

*Staff*
Elaine Alvarado (Office Manager)

*Faculty:*
Larry Caretto, Shoeleh Di Julio, Timothy W. Fox, Nhut Ho, Hamid Johari, J. Michael Kabo, C.T. Lin, Tom Mincer, Stewart Prince, Robert G. Ryan, Sidney H. Schwartz

*Emeritus Faculty*
Melvin Epstein, William J. Rivers, Charles F. Sanders

## Programs

Undergraduate Degree:
B.S., Mechanical Engineering
Graduate Degree:
M.S., Mechanical Engineering

## Accreditation

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: (410) 347-7700.

## Mission Statement

The mission of the Mechanical Engineering Department is to provide a broad, rigorous, application oriented and contemporary understanding of mechanical engineering that prepares our graduates for successful careers and life long learning.

## The Major

Mechanical Engineering majors at CSUN receive a solid basic education in the fundamentals of the discipline augmented by hands-on experience that the employers of our graduates have found to be invaluable. The program includes study of modern topics including lab courses in automated data acquisition and the interaction between mechanical and electronic systems, known as mechatronics.

The freshmen and sophomore years provide the student with a breadth of knowledge that is required in specialized courses and in the career work of the mechanical engineer. During these years, students take courses in mathematics, chemistry, physics, computer programming, engineering materials, engineering mechanics, and electrical systems. The junior year courses include engineering economics, engineering dynamics, strength of materials, thermodynamics, fluid mechanics, heat transfer, mechanical design, and the numerical analysis of engineering systems.

The senior year is composed of a group of required courses and elective courses that are related to the student's area of specialization within Mechanical Engineering. The required courses include system dynamics, mechatronics, and two semesters of senior design. Students can take their electives to obtain more in-depth knowledge in the following areas: aerospace engineering, automotive engineering, controls engineering, environmental engineering, mechanical design, and thermofluid systems.

The Mechanical Engineering Department takes a practical approach to engineering, offering hands-on design experience as well as theoretical knowledge. That's an advantage on the job because our graduates have had experience constructing projects, not just analyzing and designing them. A key to this practical training is the department's senior design program, which is modeled on the industry work groups that students will encounter on the job. Like professional engineers, our students design and develop a project, from conception through manufacture. In the process they gain valuable experience in working as a team, overcoming technical and management challenges and developing communication skills. Past senior design projects have included: autonomous intelligent ground vehicle, battle-bots, Formula SAE race car, human powered vehicle, payload maximized model aircraft, and systems for petroleum polluted soil and water cleanup.

Department lab facilities, contained in approximately a dozen labs with a total floor space of over 20,000 square feet, include:

- A lab for studying modern methods of measurement and mechatronics;
- A systems engineering lab used for research on automated air traffic simulations;
- A fully instrumented engine and vehicle performance and emissions test facility, including a chassis and several engine dynamometers;
- An environmental test chamber for temperature (-30°C to +65°C) and humidity environmental testing-includes an automotive chassis dynamometer;
- A state-of-the-art computer controlled manufacturing facility (Haas Lab) together with a student machine shop;
- Low-speed wind tunnel for testing models at up to 200 mph;
- A small rocket engine test stand in an explosion-proof test cell;
- A thermofluid systems lab used for heat transfer and fluid flow experiments;
- A controls lab used for studying automatic control systems as well as autonomous vehicles; and
- The Design, Analysis and Simulation lab, which is a computer lab containing more than 40 state-of-the-art workstations.

Through student chapters of two national organizations, the Society of Automotive Engineers and the American Society of Mechanical Engineers, students can get to know more about the field and each other outside of class.

## Educational Objectives

The CSUN undergraduate program prepares students to enter the engineering profession as a skilled practitioner who can make a solid contribution to the field, find job satisfaction, and have a lifelong career. To accomplish this overall goal, a CSUN graduate should have the following accomplishments during the first few years following graduation:

1. Have an engineering job or a position that requires the application of the graduate's engineering education.
2. A record of effective application of undergraduate educational tools to accomplish tasks assigned in the workplace. This includes mathematics, science, engineering fundamentals, and engineering design, test and evaluation.
3. Demonstrated accomplishments in preparing effective reports, technical presentations and other technical communications.
4. Has been able to learn new material required to carry out job assignments.
5. Is regarded by colleagues and supervisors as an effective member of the work team, demonstrating skills, initiative, professional and ethical responsibility and knowledge of all issues (including economic, environmental, societal, in a global context) affecting his or her work. Demonstrates appropriate leadership skills.

## Student Learning Outcomes of the Undergraduate Program

The outcomes listed below have been defined for the Mechanical Engineering Program. These outcomes as defined in ABET 2000 Criterion 3, have been modified to include the outcomes required by the program specific criteria as given by the American Society of Mechanical Engineers. The following is the list of the fifteen 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 mechanical/thermal system, component, or process to meet desired needs
d. an ability to function on multidisciplinary 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 and societal context
i. a recognition of the need for, and an ability to engage in lifelong learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
l. a knowledge of chemistry and calculus-based physics with depth in at least one
m. applied advanced mathematics through multivariate calculus and differential equations
n. familiarity in statistics and linear algebra
o. ability to work professionally in both thermal and mechanical areas including the design and realization of such systems

### Careers

Mechanical Engineers design automobiles, aircraft and space vehicles, power plants, heating and cooling systems, gas and steam turbines, servomechanisms, transmissions, engines for rockets, aircraft and ground vehicles, robots and manufacturing production lines. They use scientific knowledge to create new and useful designs and to harness various types of energy, such as chemical, solar or thermal.

Mechanical Engineering is the broadest engineering specialty. A company that employs any engineer is likely to hire some mechanical engineers. Those companies include power-generating stations, public utility companies, transportation companies, construction firms, airlines, missile and spacecraft companies, electronics companies, and the manufacturing companies that produce all forms of machinery, vehicles, aircraft, appliances, and many other products used by industry and/or consumers.

Most CSUN Mechanical Engineering graduates become practicing engineers in industry. Others, however, choose to pursue careers with government agencies or educational institutions. The degree can also be a stepping-stone to law school for a career as a patent lawyer, or to business school for careers in technical management, marketing, or sales, or even to medical school.

Many employers in our local geographic area have CSUN graduates working for them and look forward to hiring more of our graduates.

### Academic Advisement

The Mechanical Engineering faculty is committed to providing a supportive student-centered environment for their majors. All Mechanical Engineering majors at CSUN meet with their assigned faculty advisors for academic advisement. Students will need to be advised once each semester until they complete all requirements.

### Community Relations And Departmental Advisory Council

The Department maintains strong relations with the community. We continuously review our programs with students, alumni and employers of our graduates. The Department's advisory council consists of members in the professional community to ensure that we receive a breadth of information on future engineering trends that would affect our programs.

## Requirements for the Bachelor of Science in Mechanical Engineering (BSME) Degree

High School Preparation: The CSUN ME program assumes that students have a strong high school preparation in science, mathematics, and English. High school courses should include four years of mathematics, four years of English and at least a year of Chemistry and Physics with labs. The mathematics courses should include geometry, trigonometry and algebra. Calculus is desirable.

CSUN provides the opportunity for students who have not had a complete background of pre-engineering work in high school to take courses here to prepare them for the major. These additional courses will not count towards the major and may increase the time to graduate. CSUN provides testing as outlined below to ensure that students start their CSUN engineering course work at an appropriate level.

Pre-registration Testing Requirements: The campus requires all beginning students to take the Entry Level Mathematics Exam (ELM) and the English Placement Test (EPT) prior to enrolling in their course or obtain an exemption to these requirements by their score on an equivalent test. Refer to the section of this catalog entitled Appendices-Admission for further details on these exams and alternative test.

In addition to these general university requirements, students entering the Mechanical Engineering program need to take the following exams:

1. Mathematics Placement Test (MPT) is required prior to enrollment in MATH 150A. Students who have passed or are exempt from the ELM should take this exam prior to enrolling in their classes so they may be placed in the appropriate mathematics course. Students with scores of 3, 4, or 5 on the AP Calculus AB or BC are exempt from the MPT.
2. Chemistry Placement Test (CPT) is required with a minimum score of 40 prior to enrolling in CHEM 101. Students who do not achieve this score must complete CHEM 105 with a grade of C or better before taking CHEM 101. An advisor will review the details of these examinations with each student before they enroll in their courses.

### Special Grade Requirements

- All students must pass the English Placement Test with a score of 151 or higher to enroll in any engineering courses at the 200 level.
- All students must complete the lower division writing requirement before enrolling in any 300-level engineering courses.
- All students must attempt the Upper Division writing Proficiency Exam before enrolling in any 400-level engineering courses.
- Senior year courses cannot be taken unless the student has previously completed, or is concurrently completing, all freshman, sophomore, and junior year requirements. A grade of C- or better is required in all courses in the major. The Mathematics Department requires a C grade in its prerequisite courses.

**1. Lower Division Required Courses (47 Units)**

Freshman Year

| | | |
|---|---|---|
| MATH | 150A | Calculus I (5) |
| CHEM | 101/L | General Chemistry and Lab (4/1) |
| ME | 101/L | Introduction to Mechanical Engineering and Lab (1/1) |
| MATH | 150B | Calculus II (5) |
| PHYS | 220A/L | Mechanics and Lab (3/1) |

**Sophomore Year**

| | | |
|---|---|---|
| MATH | 250 | Calculus III (3) |
| PHYS | 220B/L | Electricity and Magnetism and Lab (3/1) |
| MSE | 227/L | Engineering Materials and Lab (3/1) |

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

| | | |
|---|---|---|
| MATH | 280 | Applied Differential Equations (3) |
| CE | 240 | Engineering Statics (3) |
| ECE | 240/L | Electrical Engineering Fundamentals and Lab (3/1) |
| ME | 286A/L | Mechanical Engineering Design I and Lab (2/1) |
| ME | 286B/L | Mechanical Engineering Design II and Lab (1/1) |

**2. Upper Division Required Courses (52 Units)**

**Junior Year**

| | | |
|---|---|---|
| AM | 316 | Engineering Dynamics (3) |
| AM | 317 | Mechanics Lab (1) |
| CE | 340 | Strength of Materials II (3) |
| ME | 309 | Numerical Analysis of Engineering Systems (2) |
| ME | 330 | Machine Design (3) |
| ME | 335/L | Mechanical Measurements and Lab (1/1) |
| ME | 370 | Thermodynamics (3) |
| ME | 375 | Heat Transfer I (3) |
| ME | 390 | Fluid Mechanics (3) |
| MSE | 304 | Engineering Economic Analysis (3) |

**Senior Year**

| | | |
|---|---|---|
| ME | 384 | System Dynamics: Modeling, Analysis and Simulation (3) |
| ME | 435/L | Mechatronics and Lab (2/1) |
| ME | 486A | Senior Design in Mechanical Engineering I (2) |
| ME | 486B | Senior Design in Mechanical Engineering II (2) |
| ME | 491 | Experimental Methods in Thermal-Fluids Systems (1) |

### Upper Division Senior Electives (15 Units):

Students must select 15 units of electives from 400 and/or 500-level engineering courses. These electives together with the required senior year courses listed above, constitute the student's Mechanical Engineering senior year. The elective program must be approved by the Mechanical Engineering Department before the student files a graduation check. Up to 6 units from the following list of non-ME courses may be taken as senior electives.

| | | |
|---|---|---|
| AM | 410 | Vibrations Analysis (3) |
| CE | 460/L | Engineering Hydrology and Lab (2/1) |
| CE | 487 | Water Pollution (3) |
| ECE | 410/L | Electrical Machines and Energy Conversion and Lab (3/1) |
| ECE | 411 | Electric Power Systems (3) |
| ECE | 412 | Power Electronics (3) |
| ECE | 420 | Digital Systems Design with Programmable Logic (3) |
| ECE | 425/L | Microprocessor Systems and Lab (3/1) |
| ECE | 440/L | Electronics II and Lab (3/1) |
| ECE | 501 | Introduction to Biomedical Engineering (3) |
| MSE | 527/L | Mechanical Behavior of Materials and Lab (2/1) |

| Total Units | 99 |
|---|---|

**General Education (27 Units):** Mechanical Engineering majors have to follow a modified general education program depending upon the year and enrollment status as a college student. Returning and transfer students should consult an advisor before planning their general education programs. The requirements for students entering in Fall 2006 under the new Plan R is described here. Continuing students and some first time transfer students may elect to continue with the former GE Plan C. Students should refer to prior catalog editions and consult with an academic advisor in selecting their required GE courses.

Mechanical Engineering students are required to take courses in the following GE sections: Analytical Reading and Expository Writing (3 units), Oral Communication (3 units), Social Sciences (3 units), Arts and Humanities (6 units), Comparative Cultures (6 units), Title 5 (6 units). All other GE requirements are met through completion of courses in the major.

Students are required to complete one upper division Subject Explorations or Title 5 course that satisfies the Information Competency requirement.

| Total Units Required | 126 |
|---|---|

## Requirements for the Master of Science in Mechanical Engineering (MSME) Degree

### A. Requirements for Admission to the Program

1. Satisfaction of all requirements for admission to the University (see University section regarding Graduate Programs provided elsewhere in this catalog).
2. Approval by the College of Engineering and Computer Science and the Department Graduate Coordinator.
3. Note: Graduate courses can be taken through the Tseng College of Extended Learning without formal admission to the MS program. Up to 9 of these units can be transferred into the program following admission.

### B. for Advancement to Classified Graduate Status

1. Upon completion of 12 units and satisfaction of University requirements for classified status (see University section regarding Graduate Programs provided elsewhere in this catalog).
2. Completion of all requirements noted on individual admissions documents.
3. Submission of a tentative program of study to the graduate coordinator.
4. Approval by the Department Graduate Coordinator.

### C. For the Degree

1. Completion of 30 units under the Thesis Plan, or 33 units under the Comprehensive Examination Plan.
   A. Thesis Plan
      1. 24 units of course work applicable to the M.S. degree, of which at least 18 units must be Engineering courses at the 500 or 600-level. All course work in the student's graduate program must be completed with a C or better.
      2. 6 units of Thesis, and successful defense of Thesis.
   B. Comprehensive Examination Plan
      1. 30 units of course work applicable to the M.S. degree, of which at least 21 units must be Engineering courses at the 500 or 600-level. All course work in the student's graduate program must be completed with a C or better.
      2. 3 units of Directed Comprehensive Study, and successful passage of a comprehensive examination.
2. Formal approval of granting of the degree by the Mechanical Engineering faculty.

### Required Courses (9-21 Units)

The number of required units depends on the number of "Expected Background" courses taken previously as part of a B.S. program, and whether the Thesis or Comprehensive Examination Plan is chosen. Any "Expected Background" courses not taken are required in the M.S. program. The "Prerequisites" courses or their equivalents are required if they have not been taken previously, but they do not count as part of the M.S. program. Students interested in this program, who do not have an undergraduate degree in Mechanical Engineering, should contact the Graduate Coordinator regarding prerequisite requirements.

1. **Required Core MS Program**
   **Select one of the following:**

| | | |
|---|---|---|
| ME | 501A | Seminar in Engineering Analysis I (3) |
| ME | 501B | Seminar in Engineering Analysis II (3) |

   **Select one of the following:**

| | | |
|---|---|---|
| AE | 697 | Direct Comprehensive Studies (3) |
| AE | 698 | Thesis (6) |
| ME | 697 | Direct Comprehensive Studies (3) |
| ME | 698 | Thesis (6) |

   Select at least one course from three of the four emphasis groups shown below. Students may select appropriate experimental or special topics courses in an emphasis that are not shown on the list below, with the approval of their advisor and the Graduate Coordinator.

2. **Electives (12-18 Units):**
   The number of required units of elective courses depends on the number of units of required courses, described above. The total number of units in the MS program, both required and elective, must be at least 30 (33 with comprehensive examination option). Students are expected to have the prerequisite courses listed below upon admission to the program. If they do not have these courses (or appropriate transfer courses) they will have to take the courses when then enter the MS program. Since these prerequisite courses are all 300-level courses they carry no credit towards the MS degree. The courses listed below as expected background must also be completed as part of the MS program if students have not already taken them (or appropriate transfer courses) as part of their undergraduate degree. Students can take a maximum of 6 units (thesis option) or 9 units (exam option) of 400-level courses as part of their MS program. The 400-level courses in "expected background" list, which are taken as part of the MS program, will be part of this six- or nine-unit maximum. The elective courses in the MS program are generally selected with the approval of an advisor, to be consistent with the chosen emphasis. With the approval of an advisor, courses taken outside of the Department are eligible for graduate credit. The elective courses in the MS program are normally chosen from the "Suggested Electives," for each emphasis.

### A. Aerospace Emphasis

*Prerequisites: ME 309, 370, 375, 390*

**Expected Background:**

| | | |
|---|---|---|
| AE | 472 | Aero-Propulsion Systems (3) |
| AE | 480 | Fundamentals of Aerospace Engineering (3) |
| AE | 589 | Aerodynamics (3) |

**Suggested Electives:**

| | | |
|---|---|---|
| AE | 572 | Rocket Propulsion (3) |
| AE | 586 | Aircraft Design (3) |
| AE | 672 | Advanced Aero Propulsion (3) |
| AE | 680 | Flight Vehicle Performance (3) |
| AE | 689 | Advanced Aerodynamics. (3) |

### B. Mechanical Systems Design Emphasis

*Prerequisites: ME 309, 330, 370, 375, 384, 390*

**Expected Background:**

| | | |
|---|---|---|
| AM | 410 | Vibration Analysis (3) |
| ME | 415 | Kinematics of Mechanisms (3) |
| ME | 430 | Machine Design Applications (3) |

**Suggested Electives:**

| | | |
|---|---|---|
| ME | 409 | Computer-aided Mechanical Engineering (3) |
| ME | 515 | Dynamics of Machinery (3) |
| ME | 560 | Automotive Engineering (3) |
| ME | 562 | Internal Combustion Engines (3) |
| ME | 630 | Computer-Aided Machine Design (3) |
| ME | 686A | Advanced Modeling, Analysis and optimization I (3) |
| ME | 686B | Advanced Modeling, Analysis and Optimization II (3) |

### C. System Dynamics and Controls Emphasis

*Prerequisites: ME 309, 330, 370, 375, 384, 390*

**Expected Background:**

| | | |
|---|---|---|
| AM | 410 | Vibration Analysis (3) |
| ME | 415 | Kinematics of Mechanisms (3) |
| ME | 484 | Control of Mechanical Systems (3) |

**Suggested Electives:**

| | | |
|---|---|---|
| ME | 501B | Seminar in Engineering Analysis II (3) |
| ME | 503 | Biomedical Instrumentation (3) |
| ME | 520 | Mechanics and Control (3) |
| ME | 584 | Simulation of Dynamic Systems (3) |
| ME | 684 | Design and Control of Dynamic Systems (3) |

### D. Thermofluid Systems Emphasis

*Prerequisites: ME 309, 370, 375, 390*

**Expected Background:**

| | | |
|---|---|---|
| ME | 470 | Thermodynamics II (3) |
| ME | 490 | Fluid Dynamics (3) |
| ME | 575 | Applied Heat and Mass Transfer (3) |

**Suggested Electives:**

| | | |
|---|---|---|
| ME | 485 | Principles of Pollution Control (3) |
| ME | 493 | Hydraulics (3) |
| ME | 501B | Seminar in Engineering Analysis II (3) |
| ME | 573 | Chemical Reaction Engineering (3) |
| ME | 583 | Thermal-Fluids System Design (3) |
| ME | 590 | Advanced Fluid Dynamics (3) |
| ME | 670 | Advanced Topics in Thermodynamics (3) |
| ME | 675A | Conductive and Radiative Heat Transfer (3) |
| ME | 675B | Convective Heat and Mass Transfer (3) |
| ME | 678 | Transport Phenomena (3) |
| ME | 683 | Energy Processes (3) |
| ME | 692 | Computational Fluid Dynamics (3) |

| Total Units Required | 30-33 |
|---|---|

## Course List - Aerospace Engineering

**AE 196A-Z. Experimental Topics Courses in Aerospace Engineering (1-4)**

**AE 296A-Z. Experimental Topics Courses in Aerospace Engineering (1-4)**

### Upper Division

**AE 396A-Z. Experimental Topics Courses in Aerospace Engineering (1-4)**

**AE 400A. Engineering Design Clinic I (1-3)**

Group design experience involving teams of students and faculty working on the solution of engineering design problems submitted by industry and government agencies.

**AE 400B. Engineering Design Clinic II (1-3)**

*Prerequisite: AE 400A. Continuation of AE 400A.*

**AE 472. Aeropropulsion Systems (3)**

*Prerequisites: ME 390; ME 370.* Analysis of aeropropulsion systems: gas turbine, fan jet, ram jet, scram jet, scram-rocket, solid rocket and liquid rocket systems. Introduction to aero-thermodynamics, and advanced propellant combustion processes.

**AE 480. Fundamentals of Aerospace Engineering (3)**
*Prerequisites: PHYS 220A/L; ME 390. Atmospheric structure/ space environment.* Aircraft/spacecraft configurations. Aircraft/missile systems performance: flight envelope, aerodynamic approximations, available propulsion systems, structural form; take-off, landing, climb and range. Introduction to vehicle stability and control.

**AE 486A. Senior Design in Aerospace Engineering I (2)**
*Prerequisite: Senior standing in Engineering.* Capstone design experience, simulating the "real" engineering environment. Synthesis of engineering fundamentals applied to systems design through group participation. Computer-Aided-Engineering Design. Construct, develop and test proposed design components; use of wind tunnels, engine dynamometers, computerized simulations of systems performance. Two three-hour labs per week.

**AE 486B. Senior Design in Aerospace Engineering II (2)**
*Prerequisite: AE 486A. Continuation of AE 486A.* Students carry out the group design project initiated in AE 486A. Influence of technical, legal, ethical and regulatory constraints are considered. Computer-Aided-Engineering Design methods are utilized. Two three-hour labs per week.

**AE 496A-Z. Experimental Topics Courses in Aerospace Engineering (1-4)**

**AE 498. Supervised Individual Projects (1-3)**
Studies in Aerospace Engineering with course content to be determined. (See subtitle in appropriate Schedule of Classes)

**AE 499A-C. Independent Study (1-3)**

## Graduate

**AE 572. Rocket Propulsion (3)**
*Prerequisites: ME 370 and 390 (or equivalent background).* Flight environment. Mission propulsive requirements, staging, optimization. Chemical rockets. Thrust chamber design, nozzle design, propellant storage and pressurization systems. Liquid propellant combustion and expansion; Monopropellant systems; Solid propellant grain design; combustion instabilities; multiple phase, reacting nozzle flow. Ram/rocket hybrid engines. Energy limited vs. power limited systems. Introduction to electrical rocket propulsion.

**AE 586. Aircraft Design**
*Prerequisite: AE 480.* Aircraft conceptual design, focused on industry practice, including discussion of the design process, initial sizing, selection of thrust-to-weight ratio and wing loading, configuration layout, propulsion integration, systems integration, performance optimization, and trade-off studies. Students do an individual aircraft design project. Includes performance analysis via simulated flight testing using a flight simulator.

**AE 589. Aerodynamics**
*Prerequisite: ME 390.* Prediction of aerodynamic forces due to subsonic flows over aircraft/missile wings and bodies. Calculation of pressure distribution, lift, drag, moments and wall shearing stress in incompressible flow. Compressibility corrections are considered. Impact of these calculations on aerodynamic design are evaluated.

**AE 672. Advanced Topics in Aero-Propulsion (3)**
*Prerequisites: AE 472 and 589 or equivalent.* Off-design performance of aero-propulsion systems. Solid propellant, ram jet, ram rocket, gas turbine, turbo-fan and prop-jet engines. Emphases on air-breathing applications in both subsonic and supersonic flight regimes.

**AE 680. Flight Vehicle Performance (3)**
*Prerequisite: AE 480.* Flight vehicle trajectories with emphasis on preliminary mission planning. Flight vehicle equations of motion, static and dynamic stability, longitudinal and lateral motion. Influence of aerodynamic forces and heating on trajectory, launch, boost, orbit determination and re-entry. Satellite "capture" problem. Planetary-transfer trajectories.

**AE 689. Advanced Aerodynamics (3)**
*Prerequisite AE 589 or ME 490.* Application of the principles of fluid dynamics to supersonic flows about wings and bodies. Topics include: generalized one-dimensional flow, shock waves, Prandtl-Meyer expansions, pressure distributions, lift, drag, moments and shear stresses on airfoils, wings and bodies. Applications to design are discussed.

**AE 694. Seminar in Aerospace Engineering (1-3)**
*Prerequisite: Instructor consent.* Advanced studies in selected areas of the field of Mechanical Engineering.

**AE 695A-Z. Experimental Topics Courses in Aerospace Engineering (1-4)**

**AE 696A-C. Directed Graduate Research (3)**

**AE 697. Directed Comprehensive Studies (1-3)(Credit/no Credit Only)**

**AE 698. Thesis or Graduate Project (1-6)**

**AE 699A-C. Independent Study (1-3)**

## Course List – Mechanical Engineering

**ME 101/L. Introduction to Mechanical Engineering and Lab (1/1)**
*Corequisite: ME 101L.* Freshman orientation course for the Mechanical Engineering program, the profession, and an introduction to the University. "Tools of the trade" – the internet, word processing, spreadsheets, power point, computer-aided design, basic lab measurement instruments, commercial component catalogs, and numerically controlled machine tools to support prototype fabrication are introduced in the context of engineering practice. Fundamental engineering analysis/design is explored through simple examples covering all aspects of Mechanical Engineering. One hour lecture; three hours lab per week.

**ME 125. How Things Work (3)**
*Prerequisite: Completion of the lower division writing requirement.* Intended for nonscientists seeking a connection between science and technology and the world in which they live. Primary goal is to allow students to begin to see science and technology in everyday life. How Things Work is about ordinary objects and the application of physical concepts that make them possible. Commonly used objects such as automobiles, amplifiers, cameras, airplanes and rockets, the sea and surfing, computers, etc., are used as examples to provide an easy-to-understand look at the role science and technology plays in our society. Designed for non-engineering majors. (Available for General Education: Subject Explorations – Lifelong Learning)

**ME 196A-Z/L. Experimental Topics Courses in Mechanical Engineering (1/1)** *Corequisites: ME 196AL-ZL*

**ME 286A/L. Mechanical Engineering Design I and Lab (2/1)**
*Prerequisites: PHYS 220A/L. Corequisites: ME 286AL. Recommended corequisite or preparatory: MSE 227/L.* Introduction to mechanical design, design methodology, and design for manufacturing. Engineering materials selection, metal forming/removal theory and practice. Introduction to solid modeling, drafting, and geometric dimensioning and tolerancing. Two hours lecture; one three-hour lab per week.

**ME 286B/L. Mechanical Engineering Design II and Lab (1/1)**
*Prerequisite: PHYS 220A/L. Corequisite: 286BL.* Study of the concepts and techniques used for engineering design, with an emphasis on modern computational tools used by mechanical engineers. Introduction to computing and programming skills, with applications to the analysis and optimization of mechanical systems using a spreadsheet with an

imbedded high level language. Use of engineering solid modeling/analysis software in the design process. "Hands-on" team project is required. One hour lecture; one three-hour lab per week.

**ME 296A-Z. Experimental Topics Courses in Mechanical Engineering (1-4)**

## Upper Division

**ME 309. Numerical analysis of Engineering Systems (2)**
*Prerequisites: Math 150B; ME286B/L or Comp 106/L or ECE 206/L or CE 280/L.* Features engineering problems which require the use of algorithms and numerical analysis to obtain a solution. Modern tools such as spreadsheets with imbedded high level languages are used for analysis and code development. Program documentation which requires extensive use of computer-based technical writing skills with graphical presentations. Cross section of problems are selected from various branches of engineering. Two three-hour labs each week.

**ME 330 Machine Design (3)**
*Prerequisites: ME 286B/L. Preparatory: CE 340.* Engineering principles and practice in the selection and design of fasteners, bearings, couplings, shafting, transmissions and other mechanical power transmission devices. Design Project. Three lecture hours per week.

**ME 335/l. Mechanical Measurements and Lab (1/1)**
*Prerequisite ECE 240/L; ME 286B/L. Corequisite: ME 335L.* Measurement of temperature, pressure, flow rate, force, and motion. Statistical methods for analysis of uncertainty and experiment design. Use of data acquisition software for data collection and storage. Analysis of dynamic response of instruments. Written and oral presentations of experimental results. One hour lecture and one three-hour lab per week.

**ME 370. Thermodynamics (3)**
*Prerequisites: MATH 250; PHYS 220A/L.* Fundamental theories and engineering applications of thermodynamics with emphasis of 1st and 2nd laws of thermodynamics. Thermodynamic properties of solids, liquids, gases, and mixtures. Work-producing and work-absorbing systems. Applications to design.

**ME 375. Heat Transfer I (3)**
*Prerequisites: MATH 250; PHYS 220A/L.* Basic principles of heat transfer and their application. Introduction to conductive, convective, and radiative heat transfer. Applications to design.

**ME 384. System Dynamics: Modeling, Analysis and Simulation (3)**
*Prerequisite: AM 316; ECE 240/L. Corequisite: ME 390.* Modeling of dynamic engineering systems in various energy domains: mechanical, electrical, hydraulic and pneumatic; using bond graphs, block diagrams and state equations. Analysis of response of system models. Digital computer simulation.

**ME 390. Fluid Mechanics (3)**
*Prerequisite: MATH 250; PHYS 220A/L.* Fundamental equations of fluid mechanics are derived and applied to engineering problems, with emphasis on understanding the physical principles involved. Basic developments are applied to compressible as well as incompressible fluids. Selective exploration of the state of the art of experimental knowledge in major areas of applications. Applications to design.

**ME 396A-Z. Experimental Topics Courses in Mechanical Engineering (1-4)**

**ME 400A. Engineering Design Clinic I (1-3)**
Group design experience involving teams of students and faculty working on the solution of engineering design problems submitted by industry and government agencies.

**ME 400B. Engineering Design Clinic II (1-3)**
*Prerequisite: ME 400A.* Continuation of ME 400A.

**ME 415. Kinematics of Mechanisms (3)**
*Prerequisite: AM 316; upper division standing.* Study of forces and motion of constrained mechanisms in machine systems. Analysis of linkages, cams, sliders, crank and rocker, offset crank-slider, universal joints, etc. Internal combustion engine is utilized to demonstrate application of these elements at a systems level.

**ME 430. Machine Design Applications (3)**
*Prerequisite: ME 330; CE 340.* Continuation of ME 330 with emphasis on fatigue of machine parts, life, wear and friction considerations. Turbine, pump, transmissions and other devices discussed and analyzed as case studies. Design project.

**ME 432. Machine Design Lab (1)**
*Prerequisite: ME 330.* Examination of the design process and review of machine elements. Applications of CAD to machine design: design projects with machine drawings. Introduction to machining and machine tools: fabrication of machine parts.

**ME 435/L. Mechatronics and Lab (2/1)**
*Prerequisite: ECE 240/L. Corequisite: ME 435L. Recommended corequisite: ME 335 or ECE 320.* Machine and process control applications, data acquisition systems, sensors and transducers, actuating devices, hardware controllers, transducer signal processing and conditioning. Two hours lecture and one 3-hour lab each week. (Crosslisted with ECE 435/L)

**ME 470. Thermodynamics II (3)**
*Prerequisite: ME 370.* Continuation of Thermo-dynamics I with applications to engineering systems. Gas and vapor cycles for power and refrigeration. Reactive and non-reactive mixtures. Introduction to combustion.

**ME 484/L. Control of Mechanical Systems and Lab (2/1)**
*Prerequisites: ME 384. Corequisite 484L.* Classical feedback control theory emphasizing mechanical systems. Time domain, frequency domain, techniques: stability criteria, system sensitivity. Introduction to design compensation and methods. Digital computer simulation of translational and rotational mechanical, hydraulic and pneumatic systems. Control system design projects. 2-hour lecture and one three-hour lab per week.

**ME 485. Principles of Pollution Control (3)**
*Prerequisite: ME 370.* Analysis of pollution control problems in various industrial processes and energy and transportation systems. Topics include toxic wastes, resource recovery, air and water quality control. Emphasis on engineering designs for reducing emissions and for safe disposal of industrial and domestic wastes. Consideration given to both redesign of existing processes and specification of after-treatment control systems. Impacts of control and disposal systems on energy resources are considered. Design project is required.

**ME 486A. Senior Design in Mechanical Engineering I (2)**
*Prerequisite: Senior standing in Engineering. Preparatory: ME 330; 384; 435.* Capstone design experience, simulating the 'real' engineering environment. Synthesis of engineering fundamentals applied to systems design, through group participation. Computer-Aided-Engineering Design. Construct, development and test proposed design components; use of wind tunnels, engine dynamometers, computerized simulations of systems performance. Two three-hour labs per week.

**ME 486B. Senior Design in Mechanical Engineering II (2)**
*Prerequisite: ME 486A.* Continuation of ME 486A. Students carry out the group design project initiated in ME 486A. Influence of technical, legal, ethical and regulatory constraints are considered. Computer-Aided-Engineering Design methods are utilized. Two three-hour labs per week.

**ME 486C. Design Leadership (3)**
*Prerequisite: Instructor consent.* Capstone design project management and design leadership through participation in large group simulation of Engineering design project that takes process from concept to demonstrated hardware.

**ME 490. Fluid Dynamics (3)**
*Prerequisite: ME 390.* Second-semester fluids course with applications to systems of engineering interest. Potential flows, boundary layers, duct flows, lubrication theory, lift and drag. One dimensional compressible flow with area change, friction, heating/cooling, normal shock waves, oblique shock waves, and Prandtl-Meyer expansions. Both numerical and analytical solution techniques are explored.

**ME 491. Thermal-Fluids Lab (1)**
*Prerequisite: ME 335; 370; 375; 390.* Experimental studies of fluid mechanics, thermodynamics, and heat transfer. Measurement and analysis of performance of simple cyclic devices, aerodynamic shapes, turbomachines, piping systems, and heat exchangers. one three-hour lab per week.

**ME 493. Hydraulics (3)**
*Prerequisite: ME 390.* Fundamental principles of incompressible fluid flow and their applications to pipe flow, open channel flow, and the performance of hydraulic turbomachines. Flow in pipe systems ranging from simple series systems to complex branched networks. Uniform flows, gradually varying flows, rapid transitions, and hydraulic jumps in open channels. Performance of radial, mixed-flow, and axial flow centrifugal pumps and turbines, and of impulse turbines.

**ME 494. Academic Internship (1-3)**
*Prerequisite: Sophomore, Junior or Senior standing in the Department of Mechanical Engineering, prior approval of the department internship coordinator, and in good standing as a matriculated student.* Supervised practical professional experience relevant to the field of study in approved public or private organizations. Industrial supervisor and faculty sponsor performance evaluations and student self assessment are required. A final report written by students describing the work accomplished and knowledge and skills acquired are required. Units earned may not be used to fulfill major program requirements. Enrollment is limited to six units total in any combination of A, B, C. Available for graduate credit (Letter Grade Only).

**ME 496A-Z. Experimental Topics Courses in Mechanical Engineering (1-4)**

**ME 498. Supervised Individual Projects (1-3)**
Studies in Mechanical Engineering. (See subtitle in appropriate Schedule of Classes)

**ME 499A-C. Independent Study (1-3)**

## Graduate Courses

Note that 300-level courses in Mechanical Engineering do not carry credit for a Master's degree in Mechanical Engineering.

**ME 501A. Seminar in Engineering Analysis (3)**
Analytic and numerical methods applied to the solution of engineering problems at an advanced level. Solution methods are demonstrated on a wide range of engineering topics, including structures, fluids, thermal, thermal energy transport, and mechanical systems. This course emphasizes physical phenomena that can be described by systems of Ordinary Differential Equations.

**ME 501B. Seminar in Engineering Analysis (3)**
Analytic and numerical methods applied to the solution of engineering problems at an advanced level. Solution methods are demonstrated on a wide range of engineering topics, including structures, fluids, thermal, thermal energy transport, and mechanical systems. This course emphasizes physical phenomena that can be described by Partial Differential Equations.

**ME 503. Biomedical Instrumentation (3)**
*Preparatory: Senior-standing.* Covers the design of medical instrumentation, specifically Biosensors, Therapeutic and Prosthetic Devices, Biopotential Amplifiers, and Lab Instrumentation. Applications to associated human organ systems are also covered. Multidisciplinary analysis, design, and simulation of bioengineering instrumentation are studied and implemented using computer methodology and techniques from engineering, physics, and mathematics. (Crosslisted with ECE 503)

**ME 515. Dynamics of Machines (3)**
*Prerequisite: ME 415. Recommended Corequisite: ME 501A.* Forces, motion and inertia in machines. Analysis of linkages, cams, rotor dynamics, reciprocal and rotational balancing, whirl modes and orbits, signature analysis of machine elements. Computer simulation of machinery dynamics, including the inverse dynamics.

**ME 520. Robot Mechanics and Control (3)**
*Prerequisite: ME 384 or equivalent; Corequisite: ME 415 or consent of instructor.* Overview of the state of the art of robotics and tele-robotics. Analysis, modeling, and simulation of motions, differential motions, and dynamics of robots. Emphasis will be placed on various aspects of robot controls: position and force. Experience in robot design will be gained through course projects.

**ME 560. Automotive Engineering (3)**
*Prerequisite: ME 330.* Introduction to automotive engineering. Design and Analysis of automotive chassis, suspension, steering, brakes, power plants and drive system. Vehicle dynamics, performance, and system optimization. Design project required.

**ME 562. Internal Combustion Engines (3)**
*Recommended Corequisite: ME 470.* Characteristics and Performance of internal combustion engines; emphasis on Otto and Diesel types, alternative cycles considered. Thermodynamics of cycles, combustion, emissions, ignition, fuel metering and injection, friction, supercharging and engine compounding. Three hours lecture per week.

**ME 563. Fluid Power Systems (3)**
*Prerequisite: ME 390. Recommended corequisite: ME 384.* Analysis and design of fluid power systems. Incompressible fluid mechanics, fluid power hydraulics. Hydraulic system components: pumps, accumulators, reservoirs, valves, filters, tubing and connectors. Operation and control of hydraulic power transmission systems. Applications in aircraft control, robotics, manufacturing equipment, mobile heavy machinery, etc.

**ME 571. Power Plant System Design (3)**
*Prerequisites: ME 309; 370.* Simulation and design optimization of power generating systems. Steam generating systems, turbines, cooling towers and condensers. Environmental impact, air pollution, water quality, and toxic material control. Impact of multi-unit power dispatching on system performance.

**ME 573. Chemical Reaction Engineering (3)**
*Prerequisite: ME 370.* Analysis and process design of engineering systems involving chemical reactions for which the rate of reactions must be considered. Rates of physical and chemical processes are considered; processes introduce where energy and mass transfer as well as chemical kinetics are important. Thermodynamics and chemical kinetics involved in the design of homogeneous and heterogeneous reactors. Application to combustion systems and other environmental engineering systems.

**ME 575. Applied Heat and Mass Transfer (3)**
*Prerequisite: ME 375 or equivalent.* Continuation of ME 375 with emphasis on the convective modes of heat and mass transfer. Heat exchangers, evaporation, boiling, condensation, high speed flows and combined processes are considered application to design.

**ME 583. Thermal-Fluid Systems Design (3)**
*Preparatory: ME 470; 490.* System design and optimization course that integrates the disciplines of fluid mechanics, thermodynamics and heat transfer. Intent is to build upon and extend information previously acquired in these courses. Emphasis is placed on the synthesis of components into a thermal-fluid system to accomplish a specified task with technical, economical, and social constraints. Series of design problems are assigned to the class as homework. These problems require students to incorporate design methodology into their work.

**ME 584. Modeling and Simulation of Dynamic Systems (3)**
*Prerequisites: AM 316; ME 501A.* Comprehensive and advanced treatment of the modeling techniques and response analyses of engineering dynamic systems. Both linear and nonlinear dynamic behavior of physical systems of different technical disciplines are studied with the aid of computer simulation. Mixed systems composed of electromechanical, fluid-mechanical and electrohydraulic components are also investigated. Computational and visualization tools, such as MATLAB and SIMULINK, are used to enhance analyzing and understanding of system performance.

**ME 590. Advanced Fluid Dynamics (3)**
*Prerequisite: ME 490.* Analytical and computational techniques for the solution of fluid dynamic problems. Topics include: generalized One-dimensional compressible flows, unsteady and two-dimensional compressible flows, method of characteristics, compressible laminar and turbulent boundary layers, transition to turbulence, turbulent stress models and application of computational codes to the solution of practical problems.

**ME 595A-Z. Experimental Topics Courses in Mechanical Engineering (3)**

**ME 630. Computer-Aided Design of Machinery (3)**
*Prerequisites: ME 330; 415.* Presentation and discussion on design of complex machinery based on closed or open-chain mechanisms. System approach to the design and analysis of practical systems with emphasis on the use of computer-aided engineering. Iterative design processes are exercised through completing design projects with steps of component selection and design optimization included. Pro-Engineer and Pro-Mechanica software are used to facilitate design processes.

**ME 670. Advanced Topics in Thermodynamics (3)**
*Prerequisite: ME 470; 390.* Advanced topics in thermodynamics emphasizing real fluid behavior and modeling. Interaction between thermodynamics, chemical kinetics, fluid mechanics and transport processes. Selected topics from microscopic thermodynamics applied to both equilibrium and non-equilibrium processes. Applications to real engineering systems are stressed.

**ME 675A. Conductive and Radiative Heat Transfer (3)**
*Prerequisite: ME 375.* Theory and applications of the conductive and radiative modes of heat transfer. Analytical and numerical methods for single and multi-dimensional steady state and transient conduction. Numerical and analytical techniques as applied to radiative exchanges between diffuse and specular surfaces and transfer through absorbing-transmitting media.

**ME 675B. Convective Heat and Mass Transfer (3)**
*Preparatory: ME 575.* Theory and application of convective heat and mass transfer. Free and forced convection in laminar and turbulent flows. Heat transfer with change of phase. Mass transfer applications including ablation and transpiration cooling, condensation, and evaporation.

**ME 678. Transport Phenomena (3)**
*Preparatory: ME 575; 675B.* Basic equations of heat mass and momentum transfer. Mass transfer in binary and multicomponent systems. Analysis of combined heat, mass, momentum-transfer problems. Turbulence. Chemically-reacting flows.

**ME 683. Energy Processes (3)**
*Preparatory: ME 575; 670.* Application of thermodynamic and transport processes to a design system for the development of energy resources. Emphasis is placed on new methods for the development of basic energy resources, and systems for the use and development of alternative energy sources. Topics to be considered include: Enhanced oil recovery, alternative resource technology (shale, tar sands, etc.), synthetic fuels, geothermal energy development, and other application topics at the of the instructor. Processes for improved efficiency in utilization of energy resources are also considered.

**ME 684. Design and Control of Dynamic Systems (3)**
*Prerequisite: ME 484.* Design and control of mechanical systems. Time-domain, and state space methods integrated into the design of dynamic processes. Application to automotive, aircraft, spacecraft, robots and related mechanical/aerospace systems. Digital simulations.

**ME 686A. Advanced Modeling, Analysis and Optimization I (3)**
*Prerequisite: ME501A or equivalent.* Modeling of engineering system performance and constraints; formulating systems of design rules; rules solving and optimization algorithms, and solver software. Students work as an integrated conceptual design team and share information at a CSUN Internet Virtual Design Portal. Students conduct broad based research on the selected system to harvest formulas, information and requirements needed to model the system and produce a joint report. Past systems have included solar systems and fuel cell systems.

**ME 686B. Advanced Modeling, Analysis and Optimization II (3)**
*Prerequisite: ME501A, ME686A.* Review report produced in ME686A. Continued system modeling, conduct simulations of system missions, trade-studies and optimization; application of latest integrated design methods and supporting software and apply integrated design techniques to the design of the selected engineering system. Establish Integrated Collaborative Environment (ICE) on CSUN Virtual Design Portal for team information sharing and passing design parameters between ICE Stations.

**ME 692. Computational Fluid Dynamics (3)**
*Prerequisites: ME 309; 490.* Introduction to the numerical analysis of fluid flows. Special techniques required for solution of the governing equations for viscous, inviscid and boundary layer flows. Applications to convective heat and mass transfer. Turbulence modeling and other submodels for complex engineering applications.

**ME 694. Seminar in Mechanical Engineering (1-3)**
*Prerequisite: Instructor consent.* Advanced studies in selected areas of the field of Mechanical Engineering.

**ME 695A-Z. Experimental Topics Courses in Mechanical Engineering (1-4)**

**ME 696A-Z. Directed Graduate Research (3)**

**ME 697. Directed Comprehensive Studies (3)**(Credit/No Credit Only)

**ME 698. Thesis or Graduate Project (1-6)**

**ME 699A-C. Independent Study (1-3)**