MECHANICAL ENGINEERING

Master of Science in Mechanical Engineering

In the Department of Mechanical Engineering, College of Engineering

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The Master of Science in Mechanical Engineering (MSME) program builds upon an undergraduate education and facilitates more advanced study in one of the branches of mechanical engineering.

MISSION STATEMENT

The Master of Science in Mechanical Engineering (MSME) program is a response to the increasing demand of mechanical engineers in the more advanced and rapidly developing fields such as Computer Aided Design using finite element methods, Computational Thermal and Fluid Sciences and the area of Energy Management. This program allows students to acquire specialized knowledge and research skills for the advanced work in their chosen area of concentration. Also, this program requires a student to complete an engineering project or a thesis that would demonstrate their capability to perform an independent research work. Thus, this requirement instills a great practical value into a student’s graduate work at Cal Poly Pomona.

EDUCATIONAL OBJECTIVES

Graduates of the Master of Science in Mechanical Engineering shall have:

- Knowledge of mechanical engineering principles in solid mechanics, mechanical design, dynamics, heat transfer, fluid dynamics, and computational mechanics.
- The ability to conduct engineering analyses and to develop and implement designs and problem solutions.
- An understanding of the various technical and non-technical factors that impact the feasibility and implementation of mechanical engineering projects.
- The foundation needed to develop engineering judgment via professional practice, and to effectively identify, consider and account for multiple and competing objectives.
- The technical knowledge and skills needed to pursue life-long learning, with the ability to independently extend personal knowledge and understanding of engineering topics and practices by conducting literature searches, consulting with others, and using other similar techniques.

ADMISSION TO THE PROGRAM

An applicant for admission to the program or Master of Science in Mechanical Engineering must meet university criteria as specified in the Admissions section of this catalog as well as the criteria outlined below. Applicants are advised that a reasonable proficiency in computer programming is necessary for successful completion. If the student is deficient in this area, he or she will be expected to remove the deficiency early in the program.

Successful applicants will be admitted to the program either unconditionally or with conditions imposed on them. To receive unconditional admission, an applicant must satisfy these criteria:

1. The applicant must hold a baccalaureate degree in Mechanical Engineering from a program that has been accredited by the Accreditation Board for Engineering and Technology (ABET) and for which the accreditation was in effect at the time of award of the degree. The degree must have been granted within five years prior to the proposed beginning of the graduate program.
2. The applicant must have achieved a grade point average of at least 3.00 in all undergraduate upper division coursework in mathematics, science and engineering and, additionally, in all coursework attempted with graduate standing.

Conditional admission may be granted in cases in which the applicant’s academic preparation for graduate study is such that criteria 1) and/or 2) above are not satisfied. In such cases, the applicant is required to submit recent test scores of the Graduate Record Examination, letters of recommendation, and other documents attesting to the applicant’s aptitude for graduate studies. Applicants who do not satisfy criterion 1) may be required to take a limited number of preparatory courses with no degree credit. When an applicant is admitted conditionally, the conditions to be met and the time allowed for meeting them are stated in the letter of admission. If these conditions are not satisfied, the student may be disqualified from the program.

REQUIREMENTS

A minimum of 45 quarter units (equivalent to 30 semester units) is required for awarding of the Master of Science in Mechanical Engineering degree. The specific requirements are described below. All students must complete either a Master’s thesis or a Master’s project.

In order to advance to candidacy for the Master of Science in Mechanical Engineering, the student must satisfy all of the following requirements:

1. Completion of all conditions of admission, including any preparatory courses that may have been specified.
2. Have an approved program of study on file.
3. Completion of a minimum of 32 units of coursework with a grade point average of 3.0 or better.
4. Passing the graduation writing test (GWT) or receiving a waiver.

A program of study must be submitted for approval before the end of the second quarter of attendance. At the time of filing of the program of study, the student must opt for publishing a thesis or conducting an independent study and passing a comprehensive examination as a culminating experience of his/her graduate education after completing the required coursework. The thesis effort is intended to involve independent research by the student with the goal of advancing knowledge in a specialized area. The thesis effort includes a defense of the effort by the student before a committee of faculty members. The independent study provides the student an opportunity to explore a practical and realistic industrial problem in his/her chosen field of specialization. The accompanying comprehensive examination is a test of the student’s expertise in his/her areas of coursework concentration. Information regarding the thesis and the independent study with a comprehensive examination is available at the Graduate Studies Office.

In addition, each student is responsible for satisfying all university requirements specified elsewhere in the catalog.

CURRICULUM

General requirements for advanced degrees are found in the Graduate Scholastic Requirements section of this catalog. No more than 13 units of acceptable graduate credit may be transferred from another graduate institution. No more than 13 units taken through Extended University may be used on the program of study. No more than 13 units of
acceptable graduate credit may be petitioned by an undergraduate student. A total of 13 transfer, Extended University, or units petitioned for graduate credit, or any combination of 13 units, may be included on the program of study.

The curriculum for the Master of Science in Mechanical Engineering requires a minimum of 45 units of coursework, of which at least 36 units must be in 500 and 600 level courses. Each program of study consists of at least 12 units of breadth courses, at least 12 units of technical emphasis courses, at least 12 units of elective courses, and either EGR 696, thesis (4-9 units) or EGR 692, independent study with a comprehensive examination (4 units). The breadth courses must be chosen from the sequence EGR 509 through 515. These courses are intended to insure that the student acquires a fundamental knowledge in advanced mathematics. A minimum of 12 units of technical emphasis courses must be selected from an approved course list for the MSME program. No 400-level course may be included in this category of technical emphasis, and a maximum of 4 transfer units can be used to satisfy the 12 unit requirement. The rest of the emphasis courses and electives may be chosen from an extensive list of courses in engineering and related areas of mathematics and sciences. They should be chosen in collaboration with an advisor to insure consistency with graduate goals and to assure an integrated educational experience. A course in
the program of study may be taken only after the student has satisfied the course prerequisites for enrolling in the course. It is the student’s responsibility to satisfy all prerequisites for a course before enrolling in the course.

Engineering graduate students may be granted graduate credit only for courses numbered 400 and above. A grade point average of 3.0 (B) or better must be maintained in all upper-division and all graduate courses. Candidates must be enrolled in the university during the quarter of graduation.

**Thesis or Independent Study Exam** (2 units)

**Breadth Courses (12 units minimum)**

- Adv. Differential Equations ................................. EGR 509 (4)
- Engr. Prob. and Statistics ................................. EGR 510 (4)
- Numerical Modeling ....................................... EGR 511 (4)
- Vector Analysis and Complex Variables ............... EGR 512 (4)
- Engineering Tensor Analysis ............................... EGR 513 (4)
- Variational Methods in Engineering ..................... EGR 514 (4)
- Matrix Methods in Engr .................................... EGR 515 (4)

**Technical Emphasis (12 units minimum)**

Select from the following list:

- Elasticity ......................................................... ME 520 (4)
- Conduction Heat Transfer .................................. ME 532 (4)
- Mechanical Metallurgy ..................................... ME 533 (4)
- Advanced Fluid Dynamics ................................... ME 535 (4)
- Advanced Classical Dynamics .............................. ME 536 (4)
- Advanced Engineering Thermodynamics ............... ME 545 (4)
- Advanced Mechanics of Materials ....................... ME 556 (4)
- Radiation Heat Transfer ..................................... ME 564 (4)
- Convective Heat Transfer ................................... ME 584 (4)

**Technical Electives (12-16 units)**

Select from the following list:

- Fracture of Solids ............................................. ME 534 (4)
- Advanced Transport Phenomena ......................... ME 550 (4)
- Analysis of Mechanical Designs ......................... ME 557 (4)
- Nonlinear Dynamics ......................................... ME 570 (4)
- Combustion Theory .......................................... ME 576 (4)
- Solar Energy Systems ....................................... ME 590 (4)
- Direct Energy Conversion ................................... ME 591 (4)
- Computational Fluid Dynamics ........................... ME 599 (4)
- Special Topics ................................................ ME 599 (4)

Elective courses may include up to 8 units of approved 400-level courses that are relevant to the program of study, so long as these or equivalent courses have not already been used for credit toward an undergraduate degree.

**Thesis or Independent Study Exam** ........................ (2 units)

**Graduate Course Descriptions**

**ME 520 Elasticity (4)**

Theory of stress and strain for continuous media. Stress-strain relations of elasticity. Plane stress and strain. Introduction to thermoelasticity. 4 lectures/problem-solving. Prerequisites: Upper-division courses in structural analysis and EGR 513, or consent of the instructor.

**ME 532 Conduction Heat Transfer (4)**


**ME 533 Mechanical Metallurgy (4)**

Study of the mechanical behavior of metals. Fundamental mechanisms controlling deformation phenomena, strain-hardening, creep, fatigue, and fracture. Strengthening mechanisms involving alloying and heat treatment. 4 lectures/problem-solving. Prerequisites: Undergraduate courses in strength of materials and materials science.

**ME 534 Fracture of Solids (4)**

Engineering and microscopic approaches, fracture of steels, creep and fatigue, stress corrosion cracking, and hydrogen embrittlement. 4 lectures/problem-solving. Prerequisite: Upper-division course in stress analysis.

**ME 535 Advanced Fluid Dynamics (4)**


**ME 536 Advanced Classical Dynamics (4)**

Lagrange’s equations, Hamilton’s principle, variational principles, equations of motion in Eulerian angle systems, characteristic equation of inertia matrix, cuspidal motion and nutation. 4 lectures/problem-solving. Prerequisites: EGR 515 and upper-division course in dynamics, or consent of instructor.

**ME 545 Advanced Engineering Thermodynamics (4)**


**ME 550 Advanced Transport Phenomena (4)**

Differential balances for momentum, heat, and mass transfer. Convective energy, mass, and momentum transfer; internal and external flow, exact and approximate solutions. Application for space vehicle entry, binary and multicomponent systems, nuclear reactor cooling, mass transfer and heat exchanger analysis. 4 lectures/problem-solving. Prerequisites: Upper-division courses in heat transfer and fluid mechanics.

**ME 556 Advanced Mechanics of Materials (4)**

Stress and strain analysis, 2-D elasticity problems, unsymmetrical bending, shear center, torsion of prismatic members, inelastic and...
plastic behavior in torsion and bending, topics from: micro-mechanics of
composite materials, energy methods, failure theories, theory of plates,
thick walled pressure vessels. 4 lectures/problem-solving. Prerequisite:
Upper-division course in stress analysis.

ME 557 Analysis of Mechanical Designs (4)
Analysis of common machine elements. Relation to design decision
making. Optimization, reliability, miniaturization, and statistical strength
theory. 4 lectures/problem-solving. Prerequisite: Upper-division course in
stress analysis.

ME 564 Radiation Heat Transfer (4)
Radiation properties of surfaces; radiant interchange among surfaces
separated by radiatively non-participating media including the
interchange among black and gray surfaces; radiant energy transfer
through absorbing, emitting, and scattering media. 4 lectures/problem-
solving. Prerequisite: Undergraduate course in heat transfer.

ME 570 Nonlinear Dynamics (4)
Complementary methods of nonlinear modeling of physical, chemical
and fluid systems. Analytic, topologic and computational perspectives.
Dimensions and fractals. Bifurcations and catastrophes. Deterministic
chaos. Solitons. Applications to ecology, hydrodynamics, electrical and
mechanical systems. 4 lectures/problem-solving. Prerequisite: EGR 536
or consent of the instructor.

ME 576 Combustion Theory (4)
Molecular structure and statistical thermodynamics. Real gases.
Transport phenomena. Chemical reactions in gases. Reactive gas
dynamics. Combustion phenomena and diffusion flames. Premixed gas
flames; flame propagation, cellular flames, quenching. Aerodynamics of
flames; flame shape, turbulent flames. Detonation. Applications. 4
lectures/problem-solving. Prerequisites: Undergraduate courses in
thermodynamics and heat transfer.

ME 584 Convective Heat Transfer (4)
Conservation principles. Fluid stresses and flux laws. Laminar and
turbulent boundary layers. Internal flow; noncircular cross sections, entry
lengths, asymmetric heating. External flow; variable velocity, injection,
specified temperature and heat flux distribution. Temperature dependent
fluid properties. Computer solutions. 4 lectures/problem-solving.
Prerequisite: Undergraduate course in heat transfer.

ME 590 Solar Energy Systems (4)
Analysis of advanced, hybrid solar collectors. Advanced solar energy
storage. Design of solar energy systems. 4 lectures/problem-solving.
Prerequisite: Upper-division course on solar energy or equivalent.

ME 591 Direct Energy Conversion (4)
Conversion of primary chemical, nuclear, solar and heat energy directly
to electrical energy without intermediate mechanical elements. Fuel
cells, solar cells, magnetohydrodynamic generators, and fusion plasma
generators. 4 lectures/problem-solving. Prerequisite: Upper-division
course in thermodynamics.

ME 632 Computational Fluid Dynamics (4)
Fundamentals of finite-difference methods: partial differential
equations, difference representation, stability, errors. Dynamics of a
body moving through a fluid medium. Inviscid fluid flows. Compressible
fluid flows. Viscous fluid flows. Secondary flows and flow instabilities.
Panel methods. 4 lectures/problem-solving. Prerequisites: EGR 509 and
ME 535, or ARO 301, or equivalent. Unconditional standing required.