MECHANICAL AND AEROSPACE ENGINEERING

College of Engineering

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Administrative Support Coordinator: Leanne Hayes

Students desiring detailed information should contact the department for referral to one of the faculty advisors.

Career Possibilities

Mechanical Engineer • Aerospace Engineer • Facilities Engineer • Manufacturing Engineer • Design Engineer • Sales Engineer • Plant Engineer • Safety Engineer • Tool Engineer • Project Engineer • Utilization/Test Engineer • Automotive Engineer • Production Engineer • Manufacturing Engineer • Standards Engineer • Industrial Engineer • Factory Plant Layout Engineer • Material Schedule • Tool Planner • Safety Engineer • Product Safety Engineer • Production Planner • Statistician • Staff Assistant Specification Writer • Tooling Quality Assurance Worker • Quality Planning Analyst • Process Engineering • Estimator • Manufacturing Engineering • Quality Engineer • Supervisor Vendor Quality • Production Engineer • Material Schedule • Quality Control Technician • Configuration Analyst • Quality Manager • Production Manager • Industrial Engineering • Production Safety Engineer • Safety Engineer • Metrologist • Liaison Worker • Methods and Time-Study Engineer • Traffic Control Engineer • Technical Sales Representative • Process Engineer • Estimator • Associate Engineer • Field Engineer (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

ABET Accreditation

The Bachelor of Science in Aerospace Engineering and the Bachelor of Science in Mechanical Engineering offered at the Long Beach campus are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The Mechanical Engineering Extension Program offered at Lancaster University Center, Lancaster, CA is undergoing accreditation Review in 2014- 2015.

Advisory Council

The Department of Mechanical and Aerospace Engineering is supported by a professional Advisory and Development Council (ADC) comprised of outstanding engineers and executives from industry and government agencies in Southern California. The role of the ADC is to form a liaison between the University and industry and to help the administration and faculty remain informed of modern engineering practices and help with Continuous Improvement Process (CIP).

Programs at a Glance

Undergraduate

- Bachelor of Science in Aerospace Engineering (BSAE);
- Bachelor of Science in Mechanical Engineering (BSME);
- Bachelor of Science in Mechanical Engineering - Undergraduate Extension (BSME)
- *Bachelor of Science in Manufacturing Engineering Technology.

Graduate

- Master of Science in Aerospace Engineering (MSAE);
- Master of Science in Mechanical Engineering (MSME);
- Master of Science in Engineering (MSE) with an emphasis in Management Engineering;
- Ph.D. in Engineering and Industrial Applied Mathematics (offered jointly with Claremont Graduate University).

Student Organizations

Students have the benefit of joining the student chapters of professional societies:

- AIAA (American Institute for Aeronautics and Astronautics)
- ASME (American Society for Mechanical Engineers)
- SAE (Society of Automotive Engineers)
- SPE (Society of Petroleum Engineers)
- ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers)
- SME (Society of Manufacturing Engineers)
- ASQ (American Society of Quality)
- SWE (Society of Women Engineers)
- Tau Beta Pi (Engineering Honor Society)
- Pi Tau Sigma (Mechanical Engineering Honor Society)
- Sigma Gamma Tau (Aerospace Engineering Honor Society)

As student members of professional societies, students can attend local, regional, national, and international meetings and conferences, participate in student contests, become eligible for sponsored scholarships, interact with professionals from industry, and many other benefits.

Undergraduate Programs

MECHANICAL ENGINEERING PROGRAM

The undergraduate program in mechanical engineering offered at the Long Beach campus accepts both freshmen and transfer students. Students are admitted to the program following the university admission guidelines for freshmen and major specific admission criteria for transfer students.

Extension Program

The undergraduate program in mechanical engineering is also offered as an extension program at Lancaster University Center, Lancaster, CA as part of the Antelope Valley Engineering Programs. This special program offered through the College of Continuing and Professional Education (CCPE) only accepts upper division transfer students with specific admission requirements. The extension program is a cohort-based model, allowing students to proceed as a group through the program placing greater emphasis on teamwork.

BSME Program Educational Objectives

The goal of the undergraduate program in mechanical engineering is to produce well-rounded engineers prepared for careers in mechanical engineering or related disciplines, utilizing an excellent education in the fundamentals of engineering mathematics, sciences, and design in order to:

- Create innovative solutions responsive to customer needs and meeting societal challenges;
- Apply their knowledge to communicating and translating ideas and plans into working engineering systems;
- Effectively function as a team member and/or leader in global, multi-disciplinary technical environments.

Student Learning Outcomes

The ME program Student Outcomes used to meet the Program Educational Objectives are the same as the ABET "A through K":

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 a multidisciplinary team.
E. An ability to identify, formulate and solve engineering problems.
F. An understanding of professional and ethical responsibilities.
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.

Bachelor of Science in Mechanical Engineering (120 units)

The opportunity to explore a particular area of interest is provided by additional elective courses in the senior year. Several industry and professional society sponsored scholarships and internships are available to upper division mechanical engineering students. Further information is available in the department office.

Major Declaration

Freshmen admission to engineering majors is to a 'pre-major' status (i.e., Pre-Mechanical Engineering). Continuation in the major will be subject to meeting specific lower division course and GPA requirements at CSULB that indicate the student's ability to succeed and complete the major. Transfer applicants and CSULB students seeking admission into Mechanical Engineering at the Long Beach campus must also meet similar major specific requirements. To become fully admitted into the Mechanical Engineering major at the Long Beach campus, all prospective students (i.e., pre-majors, undeclared, major changes) must have a minimum cumulative 2.5 GPA and complete the following lower-division courses:

Core Lower Division Major Requirements (grade of "C" or better required):
MATH 122 (Calculus I), MATH 123 (Calculus II), PHYS 151 (Mechanics & Heat)
General Education Foundations Courses:
Written and Oral Communication

To be admitted to the Mechanical Engineering Extension Program offered at Lancaster University Center, all prospective students must have a minimum cumulative 2.5 GPA on all transferable course work attempted, and complete course work equivalent to the following:

Core Lower Division Major Requirements – 34 units (grade of C or better required):
- MATH 122 (Calculus I), MATH 123 (Calculus II), MATH 224 (Calculus III), PHYS 151 (Mechanics & Heat), PHYS 152 (Electricity & Magnetism), CHEM 111A (General Chemistry), MAE 205 (Computer Methods), MAE 172 (Engineering Design Graphics), and CE 205 (Statics)

General Education Courses: - 27 units:
- Category A – 6 units (Written and Oral Communication)
- Category C – 9 units (Humanities, Arts)
- Category D – 9 units (US history, Constitution & American Ideals, Social Science)
- Category E – 3 units (Self-Integration)

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Minimum of 120 units including University General Education requirements. A grade of "C" or better must be achieved in all of the required courses listed below.

Lower Division:

Take all of the following courses:

CHEM 111A General Chemistry (5)
Prerequisites: A passing score on the Chemistry Placement Examination.
Corequisite: MATH 109 or higher.

CE 205 Analytical Mechanics I (Statics) (3)
Prerequisite: PHYS 151 all with a grade of "C" or better.
Prerequisite/Corequisite: MATH 123.

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)
Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)
Prerequisite: A grade of "C" or better in MATH 123 or MATH 222.

ENGR 101 Introduction to Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

MAE 101B Introduction to Mechanical Engineering (1)
Prerequisite: Freshman standing or consent of instructor and MATH 111 or MATH 113 or MATH 122 with a grade of "C" or better.

MAE 172 Engineering Design Graphics I (2)
Prerequisites: None.

MAE 205 Computer Methods in MAE (2)
Prerequisites: MATH 122 with a grade of "C" or better.

MAE 272 Introduction to Manufacturing Processes (2)
Prerequisite: MAE 172 with a grade of "C" or better.

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 122.

Take one of the following choices:

PHYS 152 Electricity and Magnetism (4)
Prerequisite: PHYS 151 with a grade of "C" or better.
Prerequisite/Corequisite: MATH 123.

or both of the following:

EE 210 Electro-Magnetic Foundations in EE (3)
Prerequisite: PHYS 151 with a grade of "C" or better.
Corequisites: MATH 123, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)
Corequisite: EE 210.

Upper Division:

Take all of the following courses:

CE 335 Fluid Mechanics (3)
Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.

CE 336 Fluid Mechanics Laboratory (1)
Prerequisite: ENGL 100 or equivalent all with a grade of "C" or better.
Prerequisite/Corequisite: C E 335.

CE 406 Project Cost-Benefit Analysis (3)
Prerequisite: GE Foundation requirements.

MATH 370A Applied Mathematics I (3)
Prerequisites: A grade of "C" or better in MATH 123. Not open to Freshmen.

MAE 300 Engineering Instrumentation and Measurement (2)
Prerequisites: MATH 224, PHYS 151, PHYS 152 all with a grade of "C" or better.

MAE 305 Numerical Methods in MAE (3)
Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.

MAE 322 Engineering Materials and Materials Processes (3)
Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.

MAE 330 Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 336 Power Plant Design (3)
Prerequisite: MAE 330 with a grade of "C" or better.

MAE 337 Thermal Engineering Laboratory (2)
Prerequisite: MAE 336 with a grade of "C" or better.

MAE 361 Materials and Properties Laboratory (1)
Prerequisites: ENGL 100 or GE Composition (Area A1), MAE 300, MAE 322, MAE 373 all with a grade of "C" or better.

MAE 371 Analytical Mechanics Dynamics (3)
Prerequisites: CE 205, MAE 205, or CE 206 and 206L all with a grade of “C” or better.

MAE 373 Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 all with a grade of "C" or better.

MAE 375 Kinematics & Dynamics of Mechanisms (3)
Prerequisites: MAE 272, MAE 371 all with a grade of "C" or better.

MAE 376 Modeling & Analysis of Dynamic Systems (3)
Prerequisite: MAE 371; MATH 370A all with a grade of "C" or better.

MAE 409A Modern Computational Aspects in Mechanical Engineering (3)
Prerequisites: Senior standing in engineering and consent of instructor.

MAE 431 Heat Transfer Systems Design (3)
Prerequisites: MAE 305, MAE 330; CE 335 all with a grade of "C" or better.

MAE 459 Professional Practice Seminar (1)
Prerequisite: Senior standing or consent of instructor.

MAE 471 Design and Analysis of Mechanical Engineering Systems I (3)
Prerequisites: MAE 373 and MAE 375 all with a grade of "C" or better.

MAE 472 Design and Analysis of Mechanical Engineering Systems II (3)
Prerequisites: MAE 330, MAE 471 all with a grade of "C" or better.

MAE 476 Mechanical Control Systems I (3)
Prerequisite: MAE 376 with a grade of "C" or better.

MAE 490 Special Topics (3)
Prerequisites: Senior standing in engineering and consent of instructor.

AEROSPACE ENGINEERING PROGRAM

BSAE Program Educational Objectives

The goal of the undergraduate program in aerospace engineering is to produce well-rounded engineers prepared for careers in aerospace engineering or related disciplines,

utilizing an excellent education in the fundamentals of engineering mathematics, sciences, and design in order to:

1. Create innovative solutions responsive to customer needs and meeting societal challenges;
2. Apply their knowledge to communicating and translating ideas and plans into working engineering systems;
3. Effectively function as a team member and/or leader in global, multi-disciplinary technical environments.

Student Learning Outcomes

The AE program Student Outcomes used to meet the Program Educational Objectives are listed below:

1. The students graduating in aerospace engineering will possess the skills in mathematics, physics and chemistry required to solve real-world problems.

2. The students will have a firm understanding of engineering science fundamentals that enables them to analyze real-world problems and propose an appropriate solution to these problems.

3. The students will have an ability to apply their knowledge in aerospace fundamental disciplines to the analysis and design of components. These aerospace fundamental disciplines include aerodynamics; aerospace materials and structures; propulsion; space environment and space systems; communications and avionics systems; orbital and flight mechanics; and stability & control.

4. The students will have the ability to work in teams and (1) carry out simplified design problems from the conceptual level to the realization of a manufacturing plan, or (2) design complex systems, such as aircraft or spacecraft, from a preliminary design point of view. Projects address economic and business aspects such as commercial viability.

5. The students will have the ability to design and conduct experiments, as well as to analyze and interpret data.

6. The students will have an understanding of professional and ethical responsibility.

7. The students will have the ability to build on their knowledge and will be trained to be lifelong learners, pursuing and interested in independent study, research and development.

8. The students will have good oral, written and graphical communication skills.

9. The students will be trained in the role of the engineer in society, and have an awareness of environmental concerns in the engineering profession.

10. The students will have knowledge of contemporary issues and current projects in aerospace engineering and of technical, design, and business challenges faced by the aerospace industry.

Bachelor of Science in Aerospace Engineering (120 units)

The curriculum is designed to supplement mathematics, science and basic engineering courses in order to give students the specialization needed in different areas of aerospace engineering. In addition to acquiring technical knowledge, graduates will have completed appropriate courses in communications and in humanistic social studies.

Major Declaration

Freshmen admission to engineering majors is to a 'pre-major' status (i.e., Pre-Aerospace Engineering). Continuation in the major will be subject to meeting specific lower division course and GPA requirements at CSULB that indicate the student's ability to succeed and complete the major. Transfer applicants and CSULB students seeking admission into Aerospace Engineering must also meet similar major specific requirements. To become fully admitted into the Aerospace Engineering major, all prospective students (i.e., pre-majors, undeclared, major changes) must have a minimum cumulative 2.5 GPA and complete the following lower-division courses with a minimum grade of "C" prior to earning 60 units:

Core Lower Division Major Requirements:
MATH 122 (Calculus I), MATH 123 (Calculus II), PHYS 151 (Mechanics & Heat)

General Education Foundations Courses:
Written and Oral Communication

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

A grade of "C" or better must be achieved in all of the required courses listed below. A minimum of 120 units is required.

There are two emphases in the BSAE Program: (1) Aeronautics, and (2) Astronautics. Aeronautics focuses on aerospace engineering as it relates to flight in the atmosphere, while Astronautics addresses space flight.

Core Requirements

Lower Division:

Take all of the following courses:

CE 205 Analytical Mechanics I (Statics) (3)
Prerequisite: PHYS 151 with a grade of "C" or better.
Prerequisite/Corequisite: MATH 123.

CHEM 111A General Chemistry (5)
Prerequisites: A passing score on the Chemistry Placement Examination.
Corequisite: MATH 109 or higher.

ENGR 101 Introduction to Engineering Profession (1)
Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122

ENGR 102 Academic Success Skills (1)
Prerequisite: ENGR 101 with a grade of "C" or better.

MAE 101A Introduction to Aerospace Engineering (1)
Prerequisites: Freshman standing or consent of instructor and MATH 111 or MATH 113 or MATH 122 with a grade of "C" or better. .

MAE 172 Engineering Design Graphics (2)
Prerequisites: None.

MAE 205 Computer Methods in Mechanical/Aerospace Engineering (2)
Prerequisites: MATH 122 with a grade of "C" or better.

MATH 122 Calculus I (4)
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)
Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)
Prerequisite: A grade of "C" or better in MATH 123 or MATH 222.

PHYS 151 Mechanics and Heat (4)
Prerequisite/Corequisite: MATH 122.

Take one of the following choices:

PHYS 152 Electricity and Magnetism (4)
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

or both of the following:

EE 210 Electro-Magnetic Foundations in EE (3)
Prerequisite: PHYS 151 with a grade of "C" or better.
Corequisites: MATH 123, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)
Corequisite: EE 210.

Upper Division:

Take all of the following courses:

ECON 300 Fundamentals of Economics (3)
Prerequisites: GE Foundation requirements.

MATH 370A Applied Mathematics I (3)
Prerequisites: A grade of "C" or better in MATH 123. Not open to Freshmen.

MAE 300 Engineering Instrumentation and Measurement (2)
Prerequisites: MATH 224, PHYS 151, PHYS 152 all with a grade of "C" or better.

MAE 305 Numerical Methods in MAE (3)
Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.

MAE 330 Engineering Thermodynamics I (3)
Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 333 Engineering Fluid Dynamics (3)
Prerequisites: CE 205, MATH 370A all with a grade of "C" or better.

MAE 334 Aerodynamics I (3)
Prerequisite: MAE 333 with a grade of "C" or better.

MAE 350 Flight Mechanics (3)
Prerequisite: CE 205 with a grade of "C" or better.

MAE 365 Aerospace Structures I (3)
Prerequisite: MAE 373 with a grade of "C" or better.

MAE 371 Analytical Mechanics II (Dynamics) (3)
Prerequisites: CE 205, MAE 205, or CE 206 and 206L all with a grade of “C” or better.

MAE 373 Mechanics of Deformable Bodies (3)
Prerequisite: CE 205 with a grade of "C" or better.

MAE 374 Mechanical Properties of Materials Lab (1)
Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor.

MAE 381 Fundamentals of Space Dynamics (3)
Prerequisites: PHYS 152, MATH 370A, and MAE 371 all with a grade of "C" or better.

MAE 390 Aerospace Engineering Seminar (1)
Prerequisite: Upper division standing.

MAE 440 Aerodynamics Laboratory (1)
Prerequisites: MAE 300 and MAE 334 all with a grade of "C" or better.

MAE 452 Propulsion (3)
Prerequisites: MAE 330 and MAE 334 all with a grade of "C" or better.

MAE 465 Aerospace Structures II (3)
Prerequisite: MAE 365 with a grade of "C" or better.

MAE 478 Aerospace Systems Design I (3)
Prerequisites: MAE 334, MAE 365, and MAE 381 all with a grade of "C" or better .
Corequisite: MAE 434, MAE 465, or MAE 481.

MAE 479 Aerospace Systems Design II (3)
Prerequisite: MAE 478 with a grade of "C" or better.

Emphasis in Aeronautics:

Take all of the following courses:

MAE 434 Aerodynamics II (3)
Prerequisite: MAE 334 with a grade of "C" or better.

MAE 451 Aircraft Preliminary Design and Performance (3)
Prerequisite: MAE 334, MAE 350 all with a grade of "C" or better, or consent of instructor.

MAE 453 Stability and Control of Aerospace Vehicles (3)
Prerequisite: MAE 350 or equivalent all with a grade of "C" or better.
Corequisite: MAE 334.

Choose one of the following courses:

MAE 422, MAE 431, MAE 435, MAE 454, MAE 476, MAE 481, MAE 483

Emphasis in Astronautics:

Take all of the following courses:

MAE 481 Space Systems Engineering (3)
Prerequisite: MAE 381 with a grade of "C" or better.

MAE 483 Space Flight and Orbital Mechanics (3)
Prerequisites: MAE 381 with a grade of "C" or better.

Choose two of the following courses:

MAE 422, MAE 431, MAE 434, MAE 435, MAE 451, MAE 453, MAE 454, MAE 476

GRADUATE PROGRAMS

The goal of the Master’s programs in mechanical and aerospace engineering, the MSAE and MSAE degrees, is to provide students with the advanced engineering education needed to enhance their careers and pursue doctoral studies.

Admission to the MSAE or MSME degree programs requires a minimum GPA of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted.

Master of Science in Mechanical Engineering

This program involves modern computational and experimental methods knowledge and skills which are of immediate practical importance. This knowledge is communicated in the advanced courses and used in the conduct of a thesis or project. The areas of study within the MSME program include:

- Dynamics, Vibration, Control, and Robotics
- Fluid and Thermal Sciences
- Materials
- Mechanics

• Design and Manufacturing

Further information may be obtained from the Department of Mechanical and Aerospace Engineering's website: http://www.csulb.edu/colleges/coe/mae.

To be considered for admission, the graduate applicant must have earned a bachelor's degree from an accredited institution, have been in good standing at the last institution attended, and have a grade point average (GPA) of at least 2.7 for the last 60 (semester) or 90 (quarter) upper-division major units attempted. The general Graduate Record Examination (GRE) is required.

Prerequisites

1. A bachelor's degree in an accredited curriculum in Mechanical Engineering, or other appropriate discipline, with a minimum grade point average of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted.
2. Students must consult with the MSME graduate advisor prior to enrolling in any courses for their program.
3. Failure to attempt to fulfill the Graduation Writing Assessment Requirement (GWAR) during the first semester in the program will prevent registration in engineering courses in subsequent semesters.

Note: Before being admitted a qualified student without a mechanical engineering undergraduate degree MUST provide a written statement to the MSME graduate advisor that he/she understands that all deficiencies must be removed before attempting graduate-level courses.

Requirements

PLAN I

Completion of a minimum of 30 units beyond the bachelor's degree in graduate and 400-level courses approved by the student's Department Graduate Advisor, including:

1. Eighteen units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved graduate or 400-level courses from appropriate areas;
3. Completion of six units of MAE 698-Thesis and submission of a written thesis.

PLAN II

Completion of a minimum of 30 units beyond the bachelor's degree in graduate and 400-level courses approved by the student's Department Graduate Advisor, including:

1. Twenty-four units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved graduate or 400-level courses from approved areas;
3. Completion of a comprehensive written exam. (Note: In order to satisfy the culminating activity requirement (thesis, project, or comprehensive examination dependent upon the program), students must earn at least three (3) units and no more than six (6) units related to the completion of the culminating activity.

Advancement to Candidacy

Prior to formally starting their thesis or project (registering for MAE 697 or 698), students must apply for Advancement to Candidacy. Students applying for Advancement to Candidacy must:

1. Have completed ALL undergraduate deficiencies with grades of "C" or better;
2. Have attained an overall grade point average (GPA) of 3.0
3. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
4. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
5. Have fulfilled the Graduation Writing Assessment Requirement (GWAR). This requirement can also be met by presenting evidence that the student met the requirement while an undergraduate at CSULB or at certain CSU campuses.
6. Have their program of studies approved by the faculty coordinating their area of emphasis, the ME program graduate advisor, and department chair.

Master of Science in Aerospace Engineering

This program involves modern computational and experimental methods and provides the essential information which will permit students to acquire the knowledge and skills which are of immediate practical importance. This knowledge is communicated in the advanced courses listed in the MAE curriculum and used in the conduct of a thesis or project. The areas of study within the MSAE program include:

• Space Systems Engineering
• Aircraft Systems Engineering
• Aerodynamics and Computational Fluid Dynamics
• Aerospace Structures and Materials

Both graduate and undergraduate programs benefit from the advice of an advisory committee comprised of senior staff from aerospace companies, government agencies, and universities. Further information may be obtained from the Department of Mechanical and Aerospace Engineering's website: http://www.csulb.edu/colleges/coe/mae.

To be considered for admission, the graduate applicant must have earned a bachelor's degree from an accredited institution, have been in good standing at the last institution attended, and have a grade point average (GPA) of at least 2.7 for the last 60 (semester) or 90 (quarter) upper-division major units attempted. The general Graduate Record Examination (GRE) is required.

Prerequisites

1. A bachelor's degree in an accredited curriculum in Aerospace or Mechanical Engineering with a minimum grade point average of 2.70 in the last 60 (semester) or 90 (quarter) upper-division major units attempted. Applicants with a lower GPA may be admitted, subject to the successful completion of appropriate deficiencies assigned by the graduate advisor.
2. A bachelor's degree in engineering, mathematics, science or other appropriate discipline, with the requirement that essential undergraduate prerequisites in engineering be satisfied.

3. Graduate students must consult with the graduate advisor for information concerning procedures and requirements for appropriate approval of their courses of study prior to enrolling in their graduate programs.

Requirements

PLAN I

Completion of a minimum of 30 units beyond the bachelor's degree in graduate and 400-level courses approved by the student's Department Graduate Advisor, including:

1. Eighteen units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved graduate or 400-level courses from appropriate areas;
3. Completion of six units of MAE 698-Thesis and submission of a written thesis.

PLAN II

Completion of a minimum of 30 units beyond the bachelor's degree in graduate and 400-level courses approved by the student's Department Graduate Advisor, including:

1. Twenty-four units of 500- and/or 600-level courses in mechanical and aerospace engineering;
2. Six units of electives selected from approved graduate or 400-level courses from approved areas;
3. Completion of a comprehensive written exam. (Note: In order to satisfy the culminating activity requirement (thesis, project, or comprehensive examination dependent upon the program), students must earn at least three (3) units and no more than six (6) units related to the completion of the culminating activity.

Advancement to Candidacy

Prior to formally starting their thesis or project (registering for MAE 697 or 698), students must apply for Advancement to Candidacy. Students applying for Advancement to Candidacy must:

1. Have completed ALL undergraduate deficiencies with grades of "C" or better;
2. Have attained an overall grade point average (GPA) of 3.0
3. Have completed at least 12 units applicable to the degree with a GPA of at least 3.0;
4. Have fulfilled the Graduation Writing Assessment Requirement (GWAR). This requirement can also be met by presenting evidence that the student met the requirement while an undergraduate at CSULB or at certain CSU campuses.
5. Have their program of studies approved by the faculty coordinating their area of emphasis, the AE program graduate advisor, and department chair.

Master of Science in Engineering

Admission to the MSE graduate program requires a minimum GPA of 2.7 in the last 60 upper-division units attempted. For requirements, see the description in the College of Engineering section of this catalog.

The Mechanical and Aerospace Engineering Department administers two emphases under the Master of Science in Engineering. The other prerequisites and requirements are the same as for the MSAE and MSME programs.

Management Engineering Emphasis

A special management perspective is required for the successful generation of technical products and services. In order to plan, design, direct and control technical projects, technical managers must be capable of inspiring and developing professional personnel. They must be able to integrate planning, manufacturing and budgetary concerns of the project and be able to easily communicate with general management.

This emphasis primarily admits students with a traditional engineering background. It emphasizes the management of engineering-based endeavors and does not require undergraduate business courses as prerequisites for graduate work. An individualized program is developed according to student's undergraduate degree, area of interest, or industrial application; interdisciplinary approaches are encouraged.

Ph.D. in Engineering and Industrial Applied Mathematics

For requirements, see the description in the College of Engineering section of this catalog.

Courses (MAE)

LOWER DIVISION

101A. Introduction to Aerospace Engineering (1)

Prerequisite: Freshman standing or consent of instructor and MATH 111 or MATH 113 or MATH 122 with a grade of "C" or better.

Role of various types of engineering specialties in the development of an actual aerospace vehicle product. Current social, ethical and environmental issues in Aerospace Engineering solutions. Life-long learning skills using resources from professional societies and Internet are also emphasized.

Letter grade only (A-F). (Lecture-problem 1 hour)

101B. Introduction to Mechanical Engineering (1)

Prerequisite: Freshman standing or consent of instructor and MATH 111 or MATH 113 or MATH 122 with a grade of "C" or better.

Introduction to mechanical engineering as a profession. Past, present, and future trends and related professional opportunities and challenges. Introduction to mechanical engineering curriculum studies. Social, economical, cultural, legal and ethical issues related to mechanical engineering and its applications.

Letter grade only (A-F)

172. Engineering Design Graphics (2)

Engineering design graphics and visualization skills using CAD software. Emphasis on industrial practice involving component and assembly modeling and drawings for actual products. Standards, tolerances, surface finishes, and other attributes of drawings addressed. Projects involving modeling of systems and subsystems.

Letter grade only (A-F). (Lecture-Problems 1 hour, Laboratory 3 hours)

205. Computer Methods in Mechanical and Aerospace Engineering (2)

Prerequisites: MATH 122 with a grade of "C" or better.

Application of computer programming to engineering problem solving. Structured approach to problems. Input-output concepts for both numerical and graphical results.

Letter grade only (A-F). (Lecture-problems 1 hour, laboratory 3 hours)

272. Introduction to Manufacturing Processes (2)

Prerequisite: MAE 172 with a grade of "C" or better.

Manufacturing processes, properties of materials; metals production; foundry, casting, heat treatment; welding, powder metallurgy, plastics, metrology; working metals, press work; machine tool elements, numerical control; metal cutting/turning; drilling, boring, milling; shaping planning, sawing broaching; grinding, sanding; gears, gear-cutting, threads, thread-cutting.

Letter grade only (A-F). (Lecture-problems 1 hour, laboratory 3 hours)

UPPER DIVISION

300. Engineering Instrumentation and Measurement (2)

Prerequisites: MATH 224, PHYS 151, PHYS 152 all with a grade of "C" or better.

Statistical analysis of experimental data, uncertainty analysis, various statistical distributions and test of goodness of fit, correlation coefficient and multivariable regression. Engineering instrumentation include types of passive/active transducers, electronics for instrumentation, computer-based data acquisition, and experiments on pressure, temperature, force measurements.

Letter grade only (A-F). (Lecture-problems 1 hour, Laboratory 3 hours)

305. Numerical Methods in Mechanical and Aerospace Engineering (3)

Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.

Roots of linear and nonlinear algebraic equations. Solutions of simultaneous linear algebraic equations. Parametric notation of analytical curves and surfaces. Numerical interpolation and splines. Numerical integration and differentiation. Numerical solution of differential equations, initial-value and boundary-value problems. Individual and/or group projects.

Letter grade only (A-F). (Lecture-problems 3 hours). Same course as MAE 305H. Not open for credit to students with credit in MAE 305H.

305H. Numerical Methods in Mechanical and Aerospace Engineering (3)

Prerequisites: MAE 205 and MATH 370A all with a grade of "C" or better.

Roots of linear and nonlinear algebraic equations. Solutions of simultaneous linear algebraic equations. Parametric notation of analytical curves and surfaces. Numerical interpolation and splines. Numerical integration and differentiation. Numerical solution of differential equations, initial-value and boundary-value problems. Individual and/or group projects.

Letter grade only (A-F). MAE 305H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 305. (Lecture-problems 3 hours)

322. Engineering Materials and Materials Processes (3)

Prerequisites: CHEM 111A, MATH 123, MAE 172 all with a grade of "C" or better.

Structure and properties of engineering materials. Phase and transformation diagrams. Heat treatments and mechanical processing. Manufacturing methods of metals. alloys, polymers, composites, ceramics, and semiconductors.

Letter grade only (A-F). (Lecture-problems 3 hours)

330. Engineering Thermodynamics I (3)

Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

Laws of thermodynamics. Properties of liquids, gases and vapors. Sources of energy and conversion to work. Introduction to heat transfer and psychrometry.

Letter grade only (A-F). (Lecture-problems 3 hours). Same course as MAE 330H. Not open for credit to students with credit in MAE 330H.

330H. Engineering Thermodynamics I (3)

Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

Laws of thermodynamics. Properties of liquids, gases and vapors. Sources of energy and conversion to work. Introduction to heat transfer and psychrometry.

Letter grade only (A-F). MAE 330H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 330. (Lecture-problems 3 hours)

333. Engineering Fluid Dynamics (3)

Prerequisites: CE 205, MATH 370A all with a grade of "C" or better.

Fluid statics. Formulation of the conservation of mass, momentum and energy using finite control volume analysis and differential analysis. Dimensional analysis. Viscous flow in pipes.

Letter grade only (A-F). (Lecture-problems 3 hours)

334. Aerodynamics I (3)

Prerequisite: MAE 333 with a grade of "C" or better.

The Bernoulli equation. Incompressible inviscid flow. Flow around circular cylinder, flow around thin airfoils. Panel method. Incompressible flow about wings of finite span. Vortex lattice method.

Letter grade only (A-F). (Lecture-problems 3 hours).

336. Power Plant Design (3)

Prerequisite: MAE 330 with a grade of "C" or better.

Design of power production systems, including steam power plants, gas turbines and auxiliary power units. Survey of alternate power sources including wind, solar, geothermal, ocean thermal and biomass. Group and/or individual design projects.

(Lecture-problems 3 hours) Letter grade only (A-F).

337. Thermal Engineering Laboratory (2)

Prerequisite: MAE 336 with a grade of "C" or better.

Thermodynamics, heat transfer and fluid flow property measurements, measurement of heating value of fuels, energy and performance analysis of thermal systems, including internal combustion engines, power and heat generating systems, refrigeration and air-conditioning systems, and heat exchangers.

(Lecture-problems 1 hour, Laboratory 3 hours) Letter grade only (A-F).

350. Flight Mechanics (3)

Prerequisite: CE 205 with a grade of "C" or better.

Turbojets: level and other flights in the vertical plane, turning flight in the horizontal plane. Piston props: level and other flights in the vertical plane, turning flight in the horizontal plane. Performance analysis and design examples.

(Lecture-problems 3 hours). Letter grade only (A-F).

361. Materials and Properties Laboratory (1)

Prerequisites: ENGL 100 or GE Composition (Area A1), MAE 300, 322, 373 all with a grade of "C" or better.

Study of the effects of thermal processing and mechanical processing on the properties and microstructures of metals, alloys, and other materials. Determination of material properties using tensile test, torsion test, and beam test. Study of the statistical nature and reliability of test results.

(Laboratory 3 hours) Letter grade only (A-F).

365. Aerospace Structures I (3)

Prerequisite: MAE 373 with a grade of "C" or better.

Mechanical behavior of aerospace materials. Torsion of thin walled section beams. Bending and torsion of advanced beams. Analysis of stiffened box beams. Load transfer in stiffened panel structures. Failure criteria of aerospace materials.

(Lecture-problems 3 hours) Letter grade only (A-F).

371. Analytical Mechanics II (Dynamics) (3)

Prerequisites: CE 205, MAE 205 or CE 206 all with a grade of "C" or better.

Newton's Laws and the principles of work and energy and impulse and momentum applied to the study of particle and rigid body motion. Engineering application with emphasis on plane motion problems. Individual and/or group projects involving in-depth numerical analysis.

(Lecture-problems 3 hours) Letter grade only (A-F). Same course as MAE 371H. Not open for credit to students with credit in MAE 371H.

371H. Analytical Mechanics II (Dynamics) (3)

Prerequisites: CE 205, MAE 205 or CE 206 and 206L all with a grade of "C" or better.

Newton's Laws and the principles of work and energy and impulse and momentum applied to the study of particle and rigid body motion. Engineering application with emphasis on plane motion problems. Individual and/or group projects involving in-depth numerical analysis.

Letter grade only (A-F). MAE 371H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 371. (Lecture-problems 3 hours)

373. Mechanics of Deformable Bodies (3)

Prerequisite: CE 205 with a grade of "C" or better.

Application of the principles of mechanics to the design of structural and machine members and connections; stress analysis of beams and columns. Properties and strength of engineering materials. Design projects.

(Lecture-problems 3 hours) Letter grade only (A-F). Same course as MAE 373H. Not open for credit to students with credit in MAE 373H.

373H. Mechanics of Deformable Bodies (3)

Prerequisite: CE 205 with a grade of "C" or better.

Application of the principles of mechanics to the design of structural and machine members and connections; stress analysis of beams and columns. Properties and strength of engineering materials. Design projects.

Letter grade only (A-F). MAE 373H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 373. (Lecture-problems 3 hours)

374. Mechanical Properties of Materials Laboratory (1)

Prerequisites: ENGL 100 or equivalent, MAE 373, and MAE 300 all with a grade of "C" or better or consent of instructor

Physical and mechanical properties of engineering materials and their relationship to structural elements; accuracy of measurements; statistical analysis of experimental data; professional laboratory reports.

(Laboratory 3 hours) Letter grade only (A-F).

375. Kinematics and Dynamics of Mechanisms (3)

Prerequisites: MAE 272, MAE 371 all with a grade of "C" or better.

Fundamentals of kinematics and dynamics of mechanisms, including structural and mobility considerations; graphical and analytical methods for linkage synthesis and position, velocity and acceleration analysis; cams and gears; analysis of combined static and dynamic forces in mechanisms.

(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F).

376. Modeling and Analysis of Dynamic Systems (3)

Prerequisite: MAE 371; MATH 370A all with a grade of "C" or better.

Modeling and analysis of dynamic systems including mechanical, electrical, electro–mechanical, and hydraulic systems. Use of complex algebra and Laplace transforms. Mathematical modeling of dynamic systems in state–space. Linear systems analysis in time and frequency domains. Introduction to feedback control systems.

(Lecture–problems 3 hours) Letter grade only (A-F).

381. Fundamentals of Spacecraft Dynamics (3)

Prerequisites: PHYS 152 or EE 210 and EE 210L, MATH 370A, and MAE 371, all with a grade of "C" or better.

Space environments and their impact on spacecraft design. Space mission engineering. Spacecraft propulsion. Attitude dynamics and kinematics. Controls. Spacecraft attitude determination and control.

(Lecture-problems 3 hours). Letter grade only (A-F).

390. Aerospace Engineering Seminar (1)

Prerequisite: Upper-division standing.

Advanced skills capstone course introducing effective oral and written communication techniques. Speakers from industry present professional practice, social responsibilities, ethical issues and latest developments in aerospace engineering. Student teams write reports and make oral presentations on topics in aerospace engineering.

(Seminar 1 hour) Letter grade only (A-F).

408./508. Systems Engineering and Integration (3)

Prerequisite: Senior standing or consent of instructor.

Introduction to tools and methods employed by systems engineers in aerospace industry. Development of system functions, requirements, verification and validation, and interfaces in the context of integrated product teams and the product life cycle. Trade studies and risk management.

(Lecture-Problems 3 hours) Letter grade only (A-F).

409A. Finite Element Methods I **(3)**

Prerequisites: Senior standing in engineering and consent of instructor.

A. Finite Element Methods I
Finite element methods for beam and truss elements. Systems of ordinary differential equations in a finite element formulation. Static and dynamic analysis of complex structures. Rigid elements in an elastic environment. Solid modeling for 1D, 2D, 3D structures using IDEAS.

B. Introduction to Computational Fluid Dynamics and Heat Transfer
Classification of partial differential equations and boundary conditions, finite difference and finite volume formulations, grid generation, stability analysis, numerical methods for inviscid flows, viscous laminar flows, compressible flows, conduction and convection heat transfer.

May be repeated to a maximum of 6 units with consent of department. (Lecture-problems 3 hours.) Letter grade only (A-F).

422./522. Composite Materials (3)

Prerequisite: MAE 373 with a grade of "C" or better.

Stress-strain relations for anisotropic materials. Classical lamination theory. Strength and failure theories for laminae and laminates. Micromechanics. Applications of composite structures. Additional projects will be required for MAE 522.

(Lecture-problems 3 hours) Letter grade only (A-F).

431. Heat Transfer Systems Design (3)

Prerequisites: MAE 305, MAE 330; CE 335 all with a grade of "C" or better.

Analysis of heat transfer by conduction, convection and radiation. Investigation of steady state and transient heat transfer systems. Computer methods. Individual-group design projects problems in heat transfer such as electronic packaging, heat exchangers, heat engines, refrigerators, and thermal systems analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

434. Aerodynamics II (3)

Prerequisite: MAE 334 with a grade of "C" or better.

Compressible flows. Subsonic and supersonic flows around airfoils and wings. Two-dimensional, incompressible boundary layers. Introduction to computational fluid dynamics (CFD). Aerodynamic design considerations. Projects are assigned and written reports are required.

(Lecture-problems 3 hours). Letter grade only (A-F).

435./535. Computational Fluid Dynamics I (3)

Prerequisites: MATH 370A, MAE 333 all with a grade of "C" or better.

Numerical methods for elliptic, parabolic, and hyperbolic equations, finite difference and volume methods, analysis of consistency, stability, and convergence, panel method, modeling and computation of boundary layer flows, full potential equation, grid generation, application to inviscid and viscous subsonic, transonic/supersonic flows.

(Lecture-Problems 3 hours) Letter grade only (A-F).

438. Heating, Ventilating, Air Conditioning, and Refrigeration (3)

Prerequisites: MAE 330, CE 335 all with a grade of "C" or better.

Basic HVAC system calculations. Thermodynamics and psychometrics, design conditions and load estimating, residential and non-residential heating and cooling load calculations, energy estimating methods, duct and pipe siding, and life cycle costs.

(Lecture-Problems 3 hours) Letter grade only (A-F).

440. Aerodynamics Laboratory (1)

Prerequisites: MAE 300 and MAE 334 all with a grade of "C" or better.

Experimental techniques in aerodynamics, wind tunnel measurements, use of Pitot tube, hot wire and Laser Doppler Velocimetry systems, flow visualization techniques, calbration of transducers. Computer controlled data acquisition and analysis. Projects are assigned and written reports and oral presentations are required.

Letter grade only (A-F). (Laboratory 3 hours)

451./551. Aircraft Preliminary Design and Performance (3)

Prerequisite: MAE 334, MAE 350 all with a grade of "C" or better, or consent of instructor.

Complete aircraft preliminary design, including mission definition, specifications, and regulations. Preliminary takeoff weight and weight empty for a mission. Aircraft geometric characteristics are developed. Detailed aerodynamic data are estimated and used to calculate aircraft performance. Individual projects required for MAE 551.

The design project is conducted in teams for MAE 451 and individually for MAE 551. (Lecture-Design Project 3 hours) Letter grade only (A-F).

452. Propulsion (3)

Prerequisites: MAE 330 and MAE 334 all with a grade of "C" or better.

Simple gas turbine cycle. Heat exchange and reheat gas turbine cycles. Gas turbine components. Ideal and actual thrust development in gas turbines. Principles of rocket engines. Solid, liquid and hybrid fuel rockets. Thrust and control in rockets.

(Lecture-problems 3 hours) Letter grade only (A-F).

453. Stability and Control of Aerospace Vehicles (3)

Prerequisite: MAE 350 or equivalent all with a grade of "C" or better.
Corequisite: MAE 334.

Physical dependence of airplane stability/control characteristics on airplane configuration and flight condition. Equations for static longitudinal, lateral and directional stability of airplanes. Neutral points, control effectiveness, trim in maneuvering flight. Configuration determinants. Transient modes. Additional Projects for MAE 553.

(Lecture-problems 3 hours) Letter grade only (A-F). Same course as MAE 453H. Not open for credit to students with credit in MAE 453H.

453H. Stability and Control of Aerospace Vehicles (3)

Prerequisite: MAE 350 or equivalent all with a grade of "C" or better.

Corequisite: MAE 334.

Physical dependence of airplane stability/control characteristics on airplane configuration and flight condition. Equations for static longitudinal, lateral and directional stability of airplanes. Neutral points, control effectiveness, trim in maneuvering flight. Configuration determinants. Transient modes.

Letter grade only (A-F). MAE 453H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 453. (Lecture-problems 3 hours)

454. Avionics Systems (3)

Prerequisite: MAE 453 with a grade of "C" or better.

Avionics systems requirements definition and design. Systems used for guidance and navigation. Components of avionics systems (software, integrated circuits, devices, etc.). Integration of optics and electronics. Testing and certification.

(Lecture-Problems 3 hours) Letter grade only (A-F).

459. Professional Practice Seminar (1)

Prerequisite: Senior standing or consent of instructor.

Professional, social and moral responsibilities of engineers. Examination of ethical and legal issues, including intellectual property rights and regulatory codes and practices. Students are encouraged to participate in professional societies and attend professional seminars. Licensure is emphasized.

(Lecture-Problems 1 hour) Letter grade only (A-F).

465. Aerospace Structures II (3)

Prerequisite: MAE 365 with a grade of "C" or better.

Fracture mechanics. Fatigue failure. Structural stability. Elementary aeroelasticity. Energy principles. Finite element methods of aerospace structural analysis. Application of finite element computer programs. Projects are assigned and written reports are required.

(Lecture-problems 3 hours). Letter grade only (A-F).

471. Design and Analysis of Mechanical Engineering Systems I (3)

Prerequisites: MAE 373 and MAE 375 all with a grade of "C" or better.

First course in a two-course integrative learning capstone design sequence. Topics include: the design process; design and selection of mechanical components; and written/oral communication. Students begin design projects in teams and progress through the preliminary stages of the design process.

(Lecture-problems 2 hours, Laboratory 3 hours) Letter grade only (A-F).

472. Design and Analysis of Mechanical Engineering Systems II (3)

Prerequisites: MAE 330, MAE 471 all with a grade of "C" or better.

Second course in a two-course integrative learning capstone design sequence. Topics include detailed engineering analysis, design decisions, fabrication of prototypes, and written/oral communication. Student teams complete design project started in MAE 471, culminating in a final design solution. Teamwork Required.

(Lecture-problems 2 hours, Laboratory 3 hours). Letter grade only (A-F).

474./574. Computer–Aided Manufacturing (3)

Prerequisites: MAE 322, MAE 490A all with a grade of "C" or better.

Fundamental concepts in automation. High volume discrete parts production systems. Numerical control manufacturing systems. Computer process monitoring. Direct digital control. Group techniques. Flexible manufacturing systems.

Letter grade only (A-F). (Lecture-Problems 2 hours, Laboratory 3 hours)

476. Mechanical Control Systems I (3)

Prerequisite: MAE 376 with a grade of "C" or better.

Feedback control systems in mechanical engineering. Modeling, analysis, and design. System performance and design criteria: stability, transient response, frequency response and compensation, root locus. Introduction to nonlinear control systems, state space analysis and design.

(Lecture-problems 2 hours, laboratory 3 hours) Letter grade only (A-F). Same course as MAE 476H. Not open for credit to students with credit in MAE 476H.

476H. Mechanical Control Systems I (3)

Prerequisite: MAE 376 with a grade of "C" or better.

Feedback control systems in mechanical engineering. Modeling, analysis, and design. System performance and design criteria: stability, transient response, frequency response and compensation, root locus. Introduction to nonlinear control systems, state space analysis and design.

Letter grade only (A-F). MAE 476H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 476. (Lecture-problems 2 hours, laboratory 3 hours)

478. Aerospace System Design I (3)

Prerequisites: MAE 334, MAE 365, and MAE 381 all with a grade of "C" or better.
Corequisite: MAE 434, MAE 465, or MAE 481.

First course in a two-course integrative learning capstone design sequence. Customer specifications are articulated in a proposal. Student teams define system requirements and work through preliminary design. Extensive design reviews (oral presentations) and written reports required.

Letter grade only (A-F). (Lecture-Design Project 2 hours, Laboratory 3 hours)

479. Aerospace Systems Design II (2)

Prerequisite: MAE 478 with a grade of "C" or better.

Second course in a two-course integrative learning capstone design sequence. Team projects started in MAE 478 are completed. Design for manufacturing. System evaluation verification and validation. Aerospace engineering ethics. Extensive design reviews (oral presentations) and written reports are required.

(Lecture-Design Project 1 hour, Laboratory 3 hours) Letter grade only (A-F).

481. Spacecraft Systems (3)

Prerequisite: MAE 381 with a grade of "C" or better.

Systems engineering approach to spacecraft design. Spacecraft systems engineering and spacecraft and power subsystem. Radiative and conductive heat transfer. Thermal control subsystem. Telecommunications. Command and data handling. Team projects including spacecraft subsystem design are assigned. Written reports and oral presentations are required.

(Lecture-Problems 3 hours) Letter grade only (A-F).

483. Space Flight and Orbital Mechanics (3)

Prerequisites: MAE 381 with a grade of "C" or better.

Two-body problem. Predicting orbital positions. Kepler's equation. Orbital elements. Lambert's problem. Rocket dynamics. Rocket payloads and staging. Impulsive orbital transfer. Interplanetary mission analysis. Projects are assigned and written reports are required.

(Lecture-problems 3 hours). Letter grade only (A-F). Same course as MAE 483H. Not open for credit to students with credit in MAE 483H.

483H. Space Flight and Orbital Mechanics (3)

Prerequisites: MAE 381 with a grade of "C" or better.

Two-body problem. Predicting orbital positions. Kepler's equation. Orbital elements. Lambert's problem. Rocket dynamics. Rocket payloads and staging. Impulsive orbital transfer. Interplanetary mission analysis. Projects are assigned and written reports are required.

Letter grade only (A-F). MAE 483H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in MAE 483. (Lecture-problems 3 hours)

490. Selected Topics in Mechanical and Aerospace Engineering (3)

Prerequisites: Senior standing in engineering and consent of instructor.

Selected topics from recent advances in mechanical and aerospace engineering. Content may vary from semester to semester.

May be repeated to a maximum of 6 units with different topics. (Lecture-problems 3 hours) Letter grade only (A-F).

A. CAD/CAM

Prerequisites: MAE 172; MAE 272 or MAE 350; MAE 322 or MAE 365; and MAE 373; upper-division standing or consent of instructor.

Not open for credit to students with credit in ME 405A.

B. Robotics Principles

Prerequisites: MAE 371, MAE 376; upper-division standing or consent of instructor.

Not open for credit to students with credit in ME 405B.

C. Energy and Resource Management (3)

Prerequisites: MAE 330 and MAE 431 all with a grade of "C" or better.

F. Petroleum Engineering

Prerequisites: Senior standing in engineering or science.

G. Mechatronics Systems Design

Prerequisites: (EE 202 and EE 346) or (MAE 300 and MAE 376) all with a grade of "C" or better or consent of instructor.

Same course as EE 442. Not open for credit to students with credit in: EE 442.

491. Special Problems (1-3)

Prerequisite: Senior standing.

Assigned topics in technical literature or laboratory projects and reports on same.

Requires consultation with the respective program's undergraduate advisor and submission of an Agreement for Independent Study form as a contract for the project and submission of a Special Problems Permission form each semester of enrollment. Instructor permission is required. May be repeated to a maximum of 3 units in different semesters. Letter grade only (A-F).

GRADUATE LEVEL

501. Engineering Analysis I (3)

Prerequisite: MATH 370A with a grade of "C" or better.

Differential equations, series solutions of differential equations (special functions), boundary-value problems and characteristic function representation, Laplace transforms, Fourier analysis, partial differential equations, formulating and solving problems in engineering for systems of differential equations and partial differential equations, complex analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

502. Engineering Analysis II (3)

Prerequisite: MAE 501 with a grade of "C" or better.

Linear algebra, matrix computations, systems of differential equations, eigenvalue problems, iterative solution of systems of algebraic equations, numerical methods for ordinary and partial differential equations, systems of nonlinear equations, optimization.

(Lecture-problems 3 hours) Letter grade only (A-F).

505. Quantitative Methods for Engineering Managers (3)

Prerequisite: MAE 501 or MAE 502 or equivalents all with a grade of "C" or better.

Concepts and methods using quantitative approaches in engineering management decision-making. Computer-based tools used in management decision-making for subjective approaches. Probabilistic methods, forms of linear program model, network analysis, dynamic programming, Monte Carlo simulation and queuing models. Methods formulating problems are emphasized.

(Lecture-problems 3 hours) Letter grade only (A-F).

506. Management of Engineering Technology and Innovation (3)

Prerequisite: Graduate engineering standing.

Analysis of the principles and theory of engineering administrative organizations, information systems, management functions, decision making tools, strategies and administrative policy formulations.

(Lecture-problems 3 hours) Letter grade only (A-F).

507. Engineering Project Management (3)

Prerequisite: Graduate engineering standing.

Theory and philosophies of project management, principles of internal and industrial organization planning and control systems, motion in time study, industrial statistics, industrial research as aid to decision making.

(Lecture-problems 3 hours) Letter grade only (A-F).

508./408. Systems Engineering and Integration (3)

Prerequisite: Senior standing or consent of instructor.

Tools and methods employed by systems engineers in aerospace industry. Development of system functions, requirements, verification and validation, and interfaces in context of integrated product teams and the product life cycle. Trade studies and risk management. Projects assigned, written reports and oral presentations are required.

Additional projects required for MAE 508. (Lecture-Problems 3 hours) Letter grade only (A-F).

512./612. Computer Aided Design in Mechanical Engineering (3)

Prerequisites: MAE 490A, MAE 501, MAE 502. (Master's students register in MAE 512 or MAE 612; Ph.D. students register in MAE 612) all with a grade of "C" or better.

Computer graphics in CAD/CAM. Includes geometrical transformations, viewing in three dimensions, modeling and object hierarchy, represenation of 3D shapes, shading models and imaging databases and data transfer.

(Lecture-problems 3 hours) Letter grade only (A-F).

521. Engineering Metallurgy II (3)

Prerequisite: MAE 322 with a grade of "C" or better.

Properties and uses of structural steels: heat treatable steels; titanium alloys; nickel and cobalt base alloys; refractory metals; ultra high-strength steels; stainless steels; and metal matrix composite materials. Designing for fracture resistance.

(Lecture-Problems 3 hours) Letter grade only (A-F).

522./422. Composite Materials (3)

Prerequisite: MAE 373 with a grade of "C" or better.

Stress-strain relations for anisotropic materials. Classical lamination theory. Strength and failure theories for laminae and laminates. Micromechanics. Applications of composite structures. Additional projects will be required for MAE 522.

(Lecture-problems 3 hours) Letter grade only (A-F).

523. Nanomaterial Properties and Applications (3)

Prerequisite: MAE 322 or equivalent, graduate student standing, or consent of instructor.

Mechanical and material characteristics of hierarchical materials with nanoscale features. Overview of synthesis, characterization techniques and applications of nanomaterials.

Lecture-problems 3 hours. Letter grade only (A-F).

524. Design of Experiments (3)

Prerequisite: MAE 300 or Consent of Instructor

This course aims to develop skills necessary to plan experimental procedures for data collection of physical systems, derive empirical models of the collected data, analyze and validate the developed empirical models, and perform optimization techniques from the empirical models.

Letter grade only (A-F). (Lecture-Problems 3 hours)

527. Metals and Plastics Manufacturing Processes (3)

Prerequisite: MAE 322 with a grade of "C" or better.

Theory of metal forming and plastics processing. Includes metal forging and rolling, metal and plastics extrusion, plastics injection molding, casting. Discussion of appropriate manufacturing methods.

(Lecture-problems 3 hours) Letter grade only (A-F).

528. Advanced Composites Manufacturing (3)

Prerequisite: Graduate standing in ME/AE or consent of instructor.

Characteristics of advanced polymer composites manufacturing processes, their capabilities, and limitations. Curing, repair, green manufacturing, and process modeling of advanced composites. Manufacturing of nanocomposites.

(Lecture-problems 3 hours.) Letter grade only (A-F).

529. Structural Analysis of Composite Laminates (3)

Prerequisite: MAE 522 with a grade of "C" or better or consent of instructor.

Beams, columns and rods of composite materials. Bending, vibration and buckling analysis of composite laminates. Shells of composite materials. Joining of composite material structures.

(Lecture-Problems 3 hours) Letter grade only (A-F).

531. Advanced Heat Transfer (3)

Prerequisites: MAE 431, MAE 501 all with a grade of "C" or better.

Advanced topics in conduction and convection heat transfer, analytical and numerical solutions to multidimensional heat conduction equations in various geometries. Solutions to laminar and turbulent convective heat transfer problems. External and internal flows, free and forced convection, and mass transfer from external surfaces. Applications in thermal systems design.

(Lecture-problems 3 hours) Letter grade only (A-F).

533. Gas Dynamics (3)

Prerequisite: MAE 333 or equivalent all with a grade of "C" or better.

Isentropic flow, normal and oblique shocks, Prandtl-Meyer flow, shock expansion theory, method of characteristics, nozzle flow, flow in ducts with friction and heat transfer, solutions of linearized potential equation with applications, slender body theory, similarity rules, transonic flow, shock wave/boundary layer interactions.

(Lecture-Problems 3 hours) Letter grade only (A-F).

535./435. Computational Fluid Dynamics I (3)

Prerequisites: MATH 370A, MAE 333 all with a grade of "C" or better.

Numerical methods for elliptic, parabolic, and hyperbolic equations, finite difference and finite volume methods, analysis of consistency, stability, and convergence, panel method, modeling and computation of boundary layer flows, etc.

Additional projects will be required for MAE 535. (Lecture-Problems 3 hours) Letter grade only (A-F).

537. Advanced Fluid Dynamics I (3)

Prerequisites: CE 335, MAE 431 all with a grade of "C" or better.

Dynamics of ideal, real and compressible flows, potential flow, vortex flow, the Navier Stokes equations, integral and differential equations for laminar flow, exact solutions for laminar flow, steady and unsteady compressible flows.

(Lecture-problems 3 hours) Letter grade only (A-F).

538. HVAC Systems, Energy Ratings and LEEDS (3)

Prerequisites: MAE 330 and CE 335, with a grade of "C" or better.

Building envelope and environment. HVAC equipment and systems. Lighting, green design and energy rating systems, and LEEDS.

Lecture-Problems 3 hours. Letter grade only (A-F)

551./451. Aircraft Preliminary Design and Performance (3)

Prerequisites: MAE 334, MAE 350 all with a grade of "C" or better, or consent of instructor.

Complete aircraft preliminary design, including mission definition, specifications and regulations. Preliminary takeoff weight and weight empty for a specific mission. Aircraft geometric characteristics are developed. Detailed aerodynamic data are estimated and used to calculate aircraft performance. The design project is conducted in teams for MAE 451 and individually for MAE 551.

(Lecture-Design Project 3 hours) Letter grade only (A-F).

553. Advanced Flight Dynamics and Control (3)

Prerequisites: MAE 502 or equivalent all with a grade of "C" or better.

Introduces the design and analysis of flight control systems. Topics include linear and nonlinear flight dynamics, state space modeling, stability analysis, modern control system design and simulation.

(Lecture-problems 3 hours) Letter grade only (A-F).

561. Fundamentals of Fracture Mechanics (3)

Prerequisite: MAE 373 or consent of instructor

The primary learning objective of the course is to thoroughly understand the basic concepts of linear-elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM) for predicting fracture and crack growth in structural components that contain cracks or crack-like defects.

Letter grade only (A-F). (Lecture-Problems 3 hours)

563. Linear Finite Element Analysis (3)

Prerequisite: MAE 409A with a grade of "C" or better.

Finite element(FE) forms of differential equations. Isoparametric concepts. Dynamic response of damped elastic structures, modal and direct integration analysis. Automatic mesh generation via solid modeling using IDEAS, automatic adaptation to popular software such as: STRUDL, NASTRAN, ANSYS, and ABAQUS. FE fluid flow and heat transfer analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

567. Advanced Mechanics of Deformable Bodies (3)

Prerequisites: MAE 373, MAE 374, MAE 471 all with a grade of "C" or better or consent of instructor.

Analysis of stress and deflection in unsymmetrical bending, shear center for beams, curved beams. Stress concentration, deformation beyond the elastic limit. Energy method; Castigliano's Theorem; Rayleigh-Ritz technique.

(Lecture-problems 3 hours) Letter grade only (A-F).

568. Creep and Fatigue (3)

Prerequisites: MAE 322, MAE 373 all with a grade of "C" or better, or consent of instructor.

Phenomena of creep and fatigue; effect on stress distribution in structural elements; buckling caused by creep; effects of space environment on fatigue; cumulative fatigue damage at normal and elevated temperatures.

(Lecture-problems 3 hours) Letter grade only (A-F).

572. Structural Design Optimization (3)

Prerequisite: MAE 373 with a grade of "C" or better or consent of instructor.

Structural optimization using calculus of variations. Method of Lagrange multipliers, unconstrained and constrained optimization, fast reanalysis techniques, sequential approximate optimization, sensitivity calculations of structural response, variational sensitivity analysis, approximation techniques, optimal design of laminated composite materials etc.

(Lecture-Problems 3 hours) Letter grade only (A-F).

573. Modern Control of Dynamic Systems (3)

Prerequisite: MAE 476 with a grade of "C" or better.

Advanced topics in analysis and design of modern control systems in mechanical engineering. Topics include state space, Riccati and Liapunov equations, Linear Quadratic Regulator (LQR), Kalman filter, etc. Optimization via calculus of variations, Pontryagin's minimum principle. Control of distributed-parameter systems with applications to structural dynamics.

Letter grade only (A-F). (Lecture-problems 3 hours)

574./474. Computer-Aided Manufacturing (3)

Prerequisites: MAE 322, MAE 490A all with a grade of "C" or better.

Fundamental concepts in automation. High volume discrete parts production systems. Numerical control manufacturing systems. Computer process monitoring. Direct digital control. Group techniques. Flexible manufacturing systems. Additional projects will be required from M.S. students in a wide–range of Engineering applications.

Letter grade only (A-F). (Lecture-Problems 2 hours, Laboratory 3 hours).

575. Robot Modeling and Control (3)

Prerequisites: MAE 371, MATH 370A all with a grade of "C" or better.

Detailed study of rigid body dynamics with emphasis on robot arm analysis. Three–dimensional kinematic analysis. Rotational and homogeneous transformations. Eulerian angles. Denavit Hartenberg representation. Kinematic chains. Recursive formulas. Euler's moment equations and gyrodynamics. Multi–body analysis. Lagrange's equations. Special topics.

(Lecture–problems 3 hours) Letter grade only (A-F).

576. Engineering Vibrations (3)

Prerequisite: MAE 376 with a grade of "C" or better.

Fundamentals of mechanical vibrations, types of oscillatory motions. Single-Degree-of-Freedom (SDOF) and Multiple-Degree-of-Freedom (MDOF) systems. Free and forced vibrations, damping, vibration isolation, vibration measuring instruments, Modal analysis. Lagrange's equations. Introduction to Finite Element Method and modal testing.

(Lecture-problems 3 hours) Letter grade only (A-F).

577. Biomechanics of Human Movement (3)

Prerequisites: MAE 371 and MATH 370A or Consent of Instructor

The course will include a review of experimental techniques used to study human movement, an introduction to advanced modeling, simulation and motion analysis techniques. Projects and demonstrations emphasize applications of mechanics in robotics, sports, orthopedics, and rehabilitation.

Letter grade only (A-F). (Lecture-Problems 3 hours)

578. Haptic Systems for Virtual Reality and Teleoperation (3)

Prerequisites: MAE 501; MAE 376 or MAE 490B and MAE 476 or equivalent all with a grade of "C" or better.

The course introduces haptic systems, which involve virtual and teleoperated environments that are displayed through force and/or tactile feedback. Topics covered include: human haptic sensing and control, design of haptic interfaces, teleoperation, modeling of virtual environments, control and stability issues.

(Lecture-Problems 3 hours) Letter grade only (A-F).

581. Space Vehicle Design (3)

Prerequisite: Graduate engineering standing or consent of instructor.

Space environments and their impact on spacecraft design. Space mission design. Payloads and communications. Integration of attitude determination and control, thermal, propulsion, configuration, telemetry, power, structures, and data handling subsystems.

(Lecture-Problems 3 hours) Letter grade only (A-F).

582. Rocket and Spacecraft Propulsion (3)

Prerequisite: Graduate engineering standing or consent of instructor.

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

(Lecture-Problems 3 hours) Letter grade only (A-F).

583. Astrodynamics (3)

Prerequisite: MAE 502 or equivalent all with a grade of "C" or better, or consent of instructor.

Physical principles. Two-body and central force motion. Coordinate and time systems. Trajectory correction maneuvers. Position and velocity in conic orbits. Lambert's Problem. Celestial mechanics. Orbital perturbations. Numerical methods in orbital mechanics and mission analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

585. Spacecraft Attitude Determination and Control (3)

Prerequisite: MAE 501 or equivalent all with a grade of "C" or better, or consent of instructor.

Control systems. Spacecraft attitude dynamics and control. Stabilization methods and maneuvers. Impact of flexible structures.

(Lecture-Problems 3 hours) Letter grading only (A-F).

590. Selected Topics in Mechanical and Aerospace Engineering (1-3)

Prerequisites: MAE 501, MAE 502 all with a grade of "C" or better, and other prerequisites as related to the topics offered, or consent of instructor.

Selected topics from recent advances in mechanical or aerospace engineering.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics in different semesters. Topics announced in the *Schedule of Classes*. (Lecture-problems 3 hours).

612./512. Computer Aided Design in Mechanical Engineering (3)

Prerequisites: MAE 490A, MAE 501, MAE 502. (Master's students register in MAE 512 or MAE 612; Ph.D. students register in MAE 612) all with a grade of "C" or better.

Computer graphics in CAD/CAM. Includes geometrical transformations, viewing in three dimensions, modeling and object hierarchy, represenation of 3D shapes, shading models and imaging databases and data transfer. Additional projects required for MAE 612.

(Lecture-problems 3 hours) Letter grade only (A-F).

631. Thermal Radiation (3)

Prerequisite: Consent of instructor.

Fundamentals of thermal radiation, properties of matter, radiative exchange in enclosures, equation of transfer for radiative transfer in absorbing, emitting, scattering media, gas radiation, and solutions for gas flows.

(Lecture-problems 3 hours) Letter grade only (A-F).

633. Hypersonic Flow (3)

Prerequisite: MAE 533 with a grade of "C" or better.

Hypersonic shock and expansion-wave relations, similarity concepts, Newtonian theory and modified Newtonian theory, nonlinear small-disturbance theory, blunt body flows, hypersonic viscous/inviscid interactions, aerodynamic heating, real gas effects, waveriders, atmospheric reentry.

(Lecture-Problems 3 hours) Letter grade only (A-F).

635./735. Computational Fluid Dynamics II (3)

Prerequisite: MAE 535 with a grade of "C" or better.

Computational methods for solving Euler and Navier-Stokes equations, implicit and explicit schemes, upwind differencing and artificial diffusion, multi-grid techniques and convergence acceleration, unstructured grid techniques, turbulence modeling, application to inviscid and viscous subsonic, transonic, and supersonic flows, inverse problems and aerodynamic shape optimization.

(Lecture-Problems 3 hours) Letter grade only (A-F).

637. Advanced Fluid Dynamics II (3)

Prerequisites: MAE 431, MAE 501, MAE 537 all with a grade of "C" or better.

Transition to turbulent flow, wall bounded and free turbulent shear flows, numerical methods for turbulent flow, turbulence modeling.

(Lecture-problems 3 hours) Letter grade only (A-F).

663./763. Nonlinear Optimized Structures (3)

Prerequisite: MAE 563, or consent of instructor. (Master's students register in MAE 663, Ph.D. students register in MAE 763) all with a grade of "C" or better.

Analysis, optimization of frame with automatic mesh generation using I-DEAS, with popular software such as: STRUDL, NASTRAN etc. Generation, idealization of complex structures. Sensitivity, Buckling analysis etc. Required topics for Ph.D. students: advanced numerical methods for flutter and random analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

669. Design of Composite Structures (3)

Prerequisite: MAE 522 all with a grade of "C" or better or consent of instructor.

Design concepts and guidelines of composite structures. Strength and stiffness design of composite laminates. Optimum design. Fatigue and creep of composite structures. Design of bolted and bonded joints.

(Lecture-Problems 3 hours) Letter grade only (A-F).

672. Stress Analysis in Design (3)

Prerequisite: MAE 567 with a grade of "C" or better or consent of instructor.

Modes of failure and failure criteria. Stability of mechanical models, elastic bars and frames by kinetic and energy approaches; design of columns, beam columns and framed columns. Plastic collapse and limit analysis. Experimental methods of stress analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

673. Theory of Elasticity and Plasticity (3)

Prerequisite: MAE 567 with a grade of "C" or better.

Equations of the mechanics of elastic bodies. Plane problem. Bending, torsion, and extension of Prismatic Bodies. Three-dimensional problem. Propagation of waves in elastic media. Approximate methods. Theory of plasticity.

(Lecture-problems 3 hours) Letter grade only (A-F).

678. Robust Control (3)

Prerequisites: MAE 476 (or an equivalent undergraduate course in classical control systems and state-space design methods), MAE 502 (or an equivalent course in linear algebra and matrix theory) all with a grade of "C" or better. Experience in basic programming and MATLAB are highly recommended.

Introduces robust analysis and design for multivariable feedback control systems with uncertain dynamics or unknown parameters. Topics include: uncertainty modeling; robust stability; robust performance; mu synthesis; H infinity control; and applications of linear matrix inequalities.

Letter grade only (A-F). (Lecture-Problems 3 hours)

690. Selected Topics in Mechanical and Aerospace Engineering (1-3)

Prerequisites: MAE 501, MAE 502 all with a grade of "C" or better, and other prerequisites as related to the topics offered, or consent of instructor.

Selected topics from recent advances in mechanical or aerospace engineering.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics in different semesters. Topics announced in the *Schedule of Classes*. (Lecture-problems 3 hours).

691. Directed Studies (1-3)

Prerequisite: Graduate Standing in a Mechanical and Aerospace Engineering graduate program.

The study of information in the engineering and scientific literature on a current topic in mechanical or aerospace engineering under the direction of a faculty member. Submission of a final written report based on the literature surveyed.

Requires consultation with the respective program's graduate advisor and submission of an Agreement for Independent Study form as a contract for the project and submission of a Directed Studies permission form each semester of enrollment. Instructor permission is required. May be repeated to a maximum of 3 units in different semesters. Letter grade only (A-F).

697. Directed Research (1-3)

Prerequisite: Graduate standing. Advancement to Candidacy strongly recommended.

Theoretical and experimental problems in MAE requiring extensive research and analysis. MAE 697 permission form required in each semester of enrollment. Agreement for Independent Study form required once per project topic.

May be repeated to a maximum of 3 units in different semesters. Not open for credit to students enrolled in MAE 698. Letter grade only (A-F).

698. Thesis (1-6)

Prerequisites: Graduate standing in a Mechanical and Aerospace Engineering graduate program and Advancement to Candidacy for the degree.

Planning, preparation, and completion of a thesis on a suitable topic in mechanical and aerospace engineering, following the library's prescribed format. The graduate advisor for the respective program and the thesis supervisor must be consulted prior to registration.

Submission of an Agreement for Independent Study form as a contract for the project and submission of a Thesis permission form are required for each semester of enrollment. Instructor permission is required. May be repeated to a maximum of 6 units in different semesters. Not open for credit to students who are enrolled in MAE 697. Letter grade only (A-F).

735./635. Computational Fluid Dynamics II (3)

Prerequisite: MAE 535 with a grade of "C" or better.

Methods for solving Euler and Navier-Stokes equations, implicit and explicit schemes, upwind differencing and artificial diffusion, multi-grid techniques and convergence acceleration, unstructured grid techniques, turbulence modeling, application to inviscid and viscous subsonic, transonic, and supersonic flows,etc.

Additional projects required for MAE 735.(Lecture-Problems 3 hours) Letter grade only (A-F).

763./663. Nonlinear Optimized Structures (3)

Prerequisite: MAE 563, or consent of instructor. (Master's students register in MAE 663, Ph.D. students register in MAE 763) all with a grade of "C" or better

Analysis, optimization of frame with automatic mesh generation using I-DEAS, with popular software such as: STRUDL, NASTRAN etc. Generation, idealization of complex structures. Sensitivity, Buckling analysis etc. Required topics for Ph.D. students: advanced numerical methods for flutter and random analysis.

(Lecture-problems 3 hours) Letter grade only (A-F).

795. Advanced Directed Studies (4)

Prerequisites: Master of Science degree or equivalent and formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics.

Exploration of theoretical and experimental (if applicable) engineering problems in great depth with an emphasis on mathematical modeling and analysis. Students must present the findings in a formal report. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required.

Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Studies permission form are required each semester of enrollment. May be repeated to a maximum of 8 units in different semesters. Letter grade only (A-F).

797. Advanced Directed Research (4)

Prerequisites: Master of Science degree or equivalent and formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics. Exploration of theoretical and experimental (if applicable) engineering problems in great depth, with emphasis on mathematical modeling and analysis. Students must present the findings in a formal report and a seminar. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required.

Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Research permission form are required each semester of enrollment. May be repeated to a maximum of 8 units in different semesters. Letter grade only (A-F).

798. Doctoral Dissertation (4-12)

Prerequisite: Enrollment is limited to students formally admitted to the Ph.D. program in Engineering and Industrial Applied Mathematics who have passed the preliminary examinations and research tool tests on completion of at least 48 units of course work. A written dissertation proposal containing an outline of the research to be undertaken must be submitted with references to relevant source material. Consultation with the respective program's graduate advisor and permission of faculty supervisor are required. Student may only embark upon the doctoral dissertation after having received a positive recommendation.

Submission of an Agreement for Independent Study form as a contract for the project and an Advanced Directed Research permission form are required each semester of enrollment. Students must enroll in a minimum of 4 units per semester. May be repeated to a maximum of 12 units in different semesters. Letter grade only (A-F).