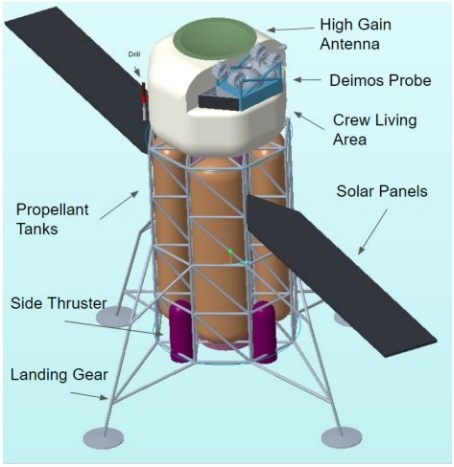
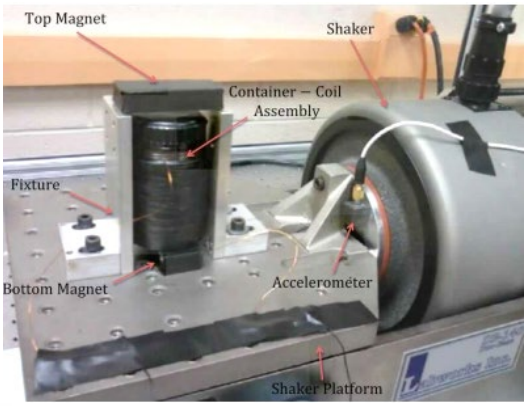
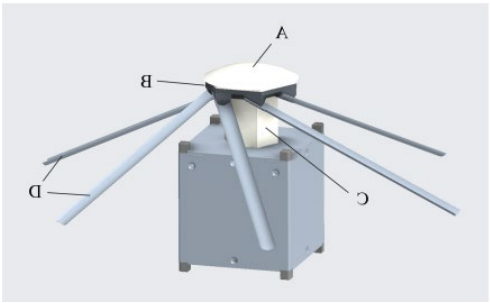
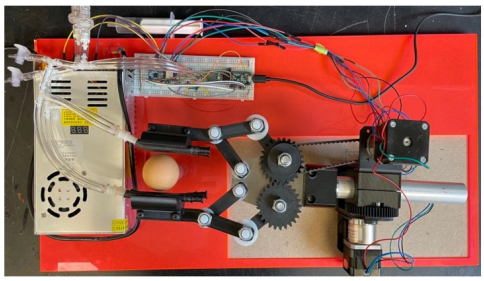
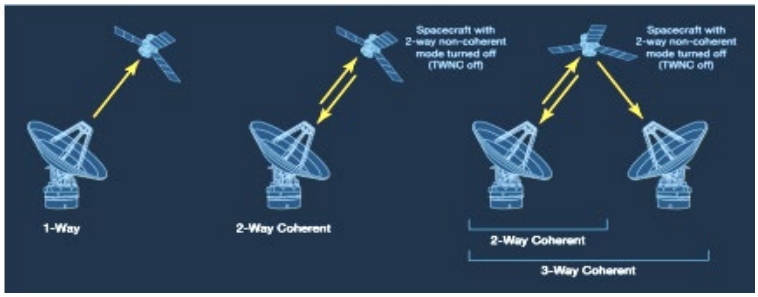
Mechanical and Aerospace Engineering Department
Undergraduate Handbook
Princeton University
Class of 2026 and beyond











PRINCETON UNIVERSITY
School of Engineering and Applied Science

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING UNDERGRADUATE PROGRAMS HANDBOOK

This booklet supersedes all others and applies to the Classes of 2026 and beyond.

This booklet describes the undergraduate academic program of the MAE Department in more detail than that available in the Undergraduate Announcement. It provides information both to prospective concentrators and to undergraduates already enrolled in the Department. For specific course descriptions see the Undergraduate Announcement or the Graduate School Announcement as appropriate.

Mechanical and Aerospace Engineering Department Web Site:
https://mae.princeton.edu/

Chair	Naomi E. Leonard	258-5129 D216 E-Quad	naomi@Princeton.EDU
Associate Chair	Michael Mueller	258-5191 D332 E-Quad	muellerm@princeton.edu
Director of Undergraduate Studies	Michael G. Littman	258-5198 D202A E-Quad	mlittman@princeton.edu
Undergraduate Administrator	Theresa Russo	258-7972 D230 E-Quad	tar3@princeton.edu
Director of Graduate Studies	Andrej Kosmrlj	258-8613 D404D E-Quad	andrej@princeton.edu
Graduate Administrator	Pamela Lattimore	258-4683 D228 E-Quad	pam.lattimore@princeton.edu
Department Manager	Caasi Love	258-5168 D214 E-Quad	clove@Princeton.EDU
Business Manager	Laurel Leonard	258-5139 D210 E-Quad	laleonard@princeton.edu

TABLE OF CONTENTS

I. OVERVIEW **1**

II. REQUIREMENTS **4**

A. Introductory Courses 4

B. Upperclass departmental Courses 5

C. General Information 7

III. RECOMMENDED SAMPLE CURRICULA **9**

A. Course Descriptions 9

B. Standard Sophomore Curriculum 13

C. Mechanical Engineering 14

D. Aerospace Engineering 19

E. mechanical and aerospace engineering 22

F. Engineering Physics Program 24

G. Materials Science and Engineering Program 25

H. Interdepartmental Programs 27

IV. DEPARTMENTAL PRIZES **29**

V. INDEPENDENT WORK AND PUBLISHED PAPERS **30**

VI. POST-GRADUATION PLANS **34**

VII. FACULTY RESEARCH INTERESTS **35**

VIII. WHO TO SEE FOR MORE INFORMATION **42**

Student Departmental Committee and other student committees 43

Interdepartmental Programs 44

Study Abroad and Foreign Exchange 45

APPENDIX I: REQUIREMENT SHEETS **47**

Aerospace Engineering 48

Mechanical Engineering 50

Aerospace and mechanical engineering 52

THE DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

I. OVERVIEW

The Department of Mechanical and Aerospace Engineering is concerned with the engineering science and technologies associated with ground, air, water, and space transportation, including control and dynamics of vehicles and systems, energy conversion and use, environmental effects, fluids, materials, and applied physics. To accommodate this breadth of interest, the Department offers two programs of study: **Mechanical Engineering** and **Aerospace Engineering.** Either program may be completed individually or, through careful planning and selection of technical electives, the requirements of both the **Mechanical and Aerospace Engineering programs** may be satisfied simultaneously. (See the Director of Undergraduate Studies for further information). Departmental students may also participate in the SEAS **Engineering Physics Program** or other SEAS programs such as **Optimization and Quantitative Decision Science** and **Engineering Biology,** as well as minor programs in **Applied and Computational Mathematics, Materials Science and Engineering, Robotics, Sustainable Energy, Computer Science and Applications of Computing.**

Both the Mechanical and Aerospace Engineering programs draw on courses in the underlying fundamental sciences and mathematics during the first year and introductory engineering science courses during the second year. Students are shown the creative application of knowledge for the solution of technical problems. Various aspects of engineering design, the process of devising a system to meet a need, are introduced to the student through the laboratories starting in the second year and continue through the upper class years. All students take a two semester design sequence and additional engineering science courses, performing analyses and studying applications in the areas of energy, power systems, structures, and the dynamics of machines and their control. The courses in design along with advanced courses in engineering science, enable students to undertake realistic design projects during their senior year. The programs are structured to prepare graduates for an engineering career and the ability to grow professionally.

The Department recognizes that students have a wide variety of career objectives. Some may intend to enter industry directly in an engineering capacity or to continue studies in the graduate school in engineering or applied science. Others may wish to take an engineering program in preparation for careers in business, law, or medicine. Sufficient flexibility is provided within the undergraduate program in the Department to permit meeting these and other varied objectives while acquiring a foundation in the engineering disciplines and associated problem-solving skills.

Independent work is an important complement to formal course work and it affords students the opportunity to collaborate closely with faculty and graduate students while working on real engineering problems. Support for student projects is available through the **John Marshall II Memorial Prize,** awarded annually to one or more seniors to support their experimental projects, with preference given to projects in aeronautics. Additionally, the **Morgan W. McKinzie '93 Senior Thesis Fund** provides financial support for independent work or senior thesis with preference given to projects in aircraft design and propulsion. The selection is based on proposals submitted by students in the fall of the senior year for both awards. Excellence in independent work is recognized by the Department through the **Donald Janssen Dike Award for Excellence in Undergraduate Research,** and outstanding senior thesis is recognized through the **Morgan W. McKinzie '93 Senior Thesis Prize.** Both prizes are awarded on Class Day.

Departmental requirements are described in Section II. Sample curricula are presented in Section III. Titles of recent independent projects undertaken by undergraduates in the Department appear in Section V. Plans after graduation for the last five classes are summarized in Section VI and a brief description of the faculty research interests is found in Section VII. Section VIII lists "Who to See" among the faculty and students to obtain additional information.

The undergraduate programs in Aerospace and Mechanical Engineering are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org .

Program(s) Educational Objectives

Aerospace Engineering:

Objective No. 1
Our graduates will think critically and creatively and excel in applying the fundamentals of aerospace engineering.

Objective No. 2
Our graduates will pursue a life of curiosity with a desire for learning and have the ability and self-confidence to adapt to rapid and major changes.

Objective No. 3
Our graduates will advance toward leadership in shaping the social, intellectual, business and technical worlds and by excelling in diverse careers.

Mechanical Engineering:

Objective No. 1

Our graduates will think critically and creatively and excel in applying the fundamentals of mechanical engineering.

Objective No. 2

Our graduates will pursue a life of curiosity with a desire for learning, and have the ability and self-confidence to adapt to rapid and major changes.

Objective No. 3

Our graduates will advance toward leadership in shaping the social, intellectual, business and technical worlds and by excelling in diverse careers.

II. REQUIREMENTS (See Individual Forms, Appendix I.)

Some of the requirements may be satisfied by equivalent courses. ***No courses taken to satisfy Mechanical or Aerospace program requirements may be taken on a pass/fail or audit basis.*** Students entering the Department are expected to meet the requirements for the 1st year established by the School of Engineering and Applied Science.

A. Introductory Courses (Sophomore Year)

The required introductory courses that are prerequisites for the Departmental upper class courses, **normally completed by the end of the sophomore year**, are:

1. Mechanical and Aerospace Engineering

   MAE 206 Introduction to Engineering Dynamics[2]
   MAE 221 Thermodynamics
   MAE 222 Mechanics of Fluids
   MAE 223 Modern Solid Mechanics[1]
   MAE 224 Integrated Laboratory
   MAE 321 Engineering Design[2]

The Sophomore Integrated Laboratory provides experiments associated with Thermodynamics (MAE 221), Mechanics of Fluids (MAE 222) and Electronics.

2. Mathematics

   MAT 201/202 Multivariable Calculus and Linear Algebra
   -or-
   MAT 203/204 Advanced Multivariable Calculus and Linear Algebra

   MAE 305 (MAT 301) Mathematics in Engineering is required for both Mechanical and Aerospace Engineers.

3. Computer Programming (School of Engineering & Applied Science requirement)

   All BSE students must take COS 126 or ECE 115 to satisfy the BSE computing

   requirement.

[1] CEE205 is an acceptable substitute for MAE 223 for those students interested in structures

[2] MAE 206 is a requirement for the Mechanical Engineering Program. It is OK to defer either MAE 206 or MAE 321 to later years if needed. For students pursing Aerospace Engineering only, MAE 206 is recommended but not required.

B. Upper Level Departmental Courses

A minimum of eight upper level Departmental courses are required for the Mechanical Program and a minimum of nine upper level Departmental courses are required for the Aerospace Program. These courses must be distributed in the following manner:

1. **Engineering Science Courses** – In the Aerospace Program six courses are required and in the Mechanical Program four courses are required from Sections (a) (b) and (c). Core requirements for both programs are footnoted.

(a) Dynamics and Control

MAE 331 Aircraft Flight Dynamics[1]
MAE 341 Space Flight[1]
MAE 345 Introduction to Robotics
MAE 433 Automatic Control Systems[2]
MAE 434 Modern Control

(b) Fluid Mechanics/Thermal Sciences

MAE 335 Fluid Dynamics [3]
MAE 423 Heat Transfer[3]
MAE 426 Rocket and Air-Breathing Propulsion Technology[4]
MAE 427 Energy Conversion and the Environment: Transportation Applications[4]
MAE 438 Electrochemical Engineering
CBE 341 Mass, Momentum, and Energy Transport[5]

(c) Materials/Structures

MAE 323 Aerospace Structures[7]
MAE 324 Structure and Properties of Materials[6]
MSE 301 Materials Science and Engineering[6]
CEE 312 Statics of Structures[7]
CEE 361/MAE 325 Structural Analysis and Intro to Finite Element Methods[7]
CEE 362 Structural Dynamics and Earthquake Engineering[8]
CEE 364 Materials in Civil Engineering[8]

---

[1] MAE 331 or 341 required for Aerospace Engineers.
[2] MAE 433 required for Mechanical and Aerospace Engineers.
[3] MAE 335 or 423 required for Mechanical Engineers. MAE 335 only required for Aerospace Engineers.
[4] MAE 427 or 426 required for Aerospace Engineers (may be used as additional engineering science elective (technical elective) in the Mechanical Program.
[5] CBE 341 is an acceptable substitute for MAE 423 for Mechanical Engineers.
[6] MAE 324 or MSE 301 required for Mechanical and Aerospace Engineers.
[7] MAE 323 or CEE 312 or CEE 361 required for Mechanical and Aerospace Engineers.
[8] CEE 362 or CEE 364 may be considered as substitutes for the materials requirement. Requires the approval of the Director of Undergraduate Studies.

2. **Engineering Design Courses** – There are three design requirements in each program. Two are satisfied by completing courses appropriate to the program (core course requirements for each program are footnoted below). The third is satisfied by completing Senior Independent Work, Senior Thesis, or Senior Project (see Section C.3). If you are completing both the Mechanical and Aerospace Programs your design requirements would be MAE 321 Engineering Design, a Mechanical Design course (MAE 412 or MAE 322 or MAE 416) and an Aerospace Design course (MAE 332 or MAE 342). You will still need to complete Senior Independent Work, Senior Thesis, or Senior Project.

   MAE 321 Engineering Design[1]
   MAE 322 Mechanical Design[2]
   MAE 332 Aircraft Design[3]
   MAE 342 Space System Design[3]
   MAE 412 Microprocessors for Measurement and Control[2]
   MAE 416 Bioinspired Design[2]
   CEE 477 Engineering Design for Sustainable Development[4]

3. **Senior Independent work** - is the culminating experience for the mechanical and aerospace engineering programs. All seniors are required to participate in a research or engineering project. All projects must include elements of engineering design *(engineering design is the process of devising a system, component, or process to meet desired needs).* The following courses satisfy this requirement: MAE 439 Senior Independent Work (one semester, fall); MAE 440 Senior Independent Work (one semester, spring); MAE 442 Senior Thesis (year-long); MAE 444 Senior Project (year-long). **Students are strongly encouraged to select the year-long project or thesis option.** Senior projects are intended for teams or groups while senior thesis is intended for individuals. For senior projects or thesis, work begins in the fall but enrollment is only in spring term when a double grade is awarded. *Please note: If a student has selected to participate in a year-long project or thesis and is enrolled in only three courses during the fall semester, it is required that they will enroll in Senior Project or Thesis during the spring semester. For these students, it will NOT be possible to drop-down to a one-semester course of Independent Work without incurring a failure for Independent Work in the fall term. In the Spring term you must enroll in three taught courses plus a senior thesis or senior project (senior thesis and senior project count as two courses). Therefore, your senior year course load will be 3 in fall and 5 in spring as opposed to 4 in fall and 4 in spring. There are NO exceptions to this rule, even if your total number of courses will exceed 36.*

   MAE 439/440 (Fall/Spring)
   MAE 442 Senior Thesis (Spring)[5]
   MAE 444 Senior Project (Spring)[5]

[1] Required for Mechanical Engineers and Aerospace Engineers.
[2] MAE 322, MAE 412 or MAE 416 required for Mechanical Engineers.
[3] MAE 332 or MAE 342 required for Aerospace Engineers.
[4] CEE 477 is an acceptable substitute only for Mechanical Engineers who are pursuing the Sustainable Energy Program
[5] Year-long project with enrollment in spring semester only

None of the Department requirements can be taken on a pass/fail or audit basis. All requests for substitution, other than those listed under the Engineering Physics Program (Section E), must be approved by the Departmental Representative in advance.

4. The Engineering School requirements in the **humanities and social sciences** must also be met (a minimum of seven courses covering four distinct areas from the seven areas offered). See the Undergraduate Announcement for full description and distribution areas. In addition, a one semester writing course is required. This course is typically completed in the 1st year.

C. General Information

Students are encouraged to elect more than the one required semester of independent work as part of their plan of study and to participate in the extensive research programs of the Department.

Additional technical courses (which may include both undergraduate and graduate courses) can be used to pursue a specialty within the Department in greater depth.

It is also possible to participate in a variety of interdepartmental programs or expand one's studies in the humanities or social sciences beyond the seven courses required by the School of Engineering and Applied Science.

Professional Ethics

Professional ethics is an important topic for all engineers. Honor code, adherence to University Regulations and adherence to rules in individual courses and laboratories are all part of our student's exposure to professional ethical matters. In addition, aspects of engineering ethics are considered in engineering courses through examples and case studies. Given that mechanical and aerospace engineering works have an impact on society, the concepts of economical and safe design are the foundations of ethical conduct of practitioners in the field. Students are urged to understand ethical guidelines further in the mechanical and aerospace fields as defined by the engineering societies:

ASME (http://www.asme.org/about-asme/governance/asme-society-policies)
Scroll to Policy 15.7 Ethics (available in PDF or Word format)
AIAA (https://www.aiaa.org/about/Governance/Code-of-Ethics)

Grading Guidelines

Course work in the MAE Department involves analysis and quantitative thinking. Student performance is usually evaluated by problem sets and examinations and sometimes by other mechanisms such as laboratory reports, group projects, class participation, or term papers. Instructors are expected, at the beginning of the semester, to specify which types of assessment will be used in determining the final course grade and the fraction by which each component will be weighted. Instructors should specify expectations for all assigned work, and the grades should reflect the degree to which students have met these expectations. An instructor may use a curve to help distribute final course grades. However, instructors should not use quotas, such as the number or percentage of A grades.

Following the Princeton University grading policy, guidelines for the assignment of each grade are given below:

Grading Definitions		
A+	Exceptional	Significantly exceeds the highest expectations for undergraduate work
A	Outstanding	Meets the highest standards for the assignment or course
A-	Excellent	Meets very high standards for the assignment or course
B+	Very good	Meets high standards for the assignment or course
B	Good	Meets most of the assignment or course
B-	More than adequate	More than adequate; shows some reasonable command of the material
C+	Acceptable	Meets basic standards for the assignment or course
C	Acceptable	Meets some of the basic standards for the assignment or course
C-	Acceptable	While acceptable, falls short of meeting basic standards in several ways
D	Minimally acceptable	Acceptable Lowest passing grade
F	Failing	Very poor performance

Office of the Dean of the College Grading Guidelines:

https://odoc.princeton.edu/faculty/teaching-support/grading-policies

Honors

The determination of honors upon graduation is made by the faculty of the Department based primarily on the grade average achieved during junior and senior year in both required and elective technical courses. The student's overall academic record and performance in independent work is also considered.

The completion of all the Departmental requirements, together with an average of 2.0* or better in the Departmental courses will lead to a Departmental recommendation that the student graduate. The decision to deny a recommendation for graduation to any student failing to meet the criteria above will be made by the Departmental faculty on the basis of a full review of the student's record.

*The grade average will be computed on the basis of equal weighing of the grades in the Departmental courses within the following numerical equivalents: A+ = 4.0, A = 4.0, A- = 3.7, B+ = 3.3, B = 3.0, B- = 2.7, C+ = 2.3, C = 2.0, C- = 1.7, D = 1.0, F = 0.0

III. RECOMMENDED SAMPLE CURRICULA

Each student's program is planned individually in consultation with their advisor or the Director of Undergraduate Studies. Sample curricula for the major options within the Department are presented later in this booklet. These sample curricula should be used as recommendations only. Individual variations are possible (and encouraged) as long as the Departmental requirements are satisfied.

A. Course Descriptions

Descriptions of the courses offered appear in the Undergraduate Announcement or the Graduate School Announcement, as appropriate. Additional information can be obtained by contacting the instructor in charge. The list below summarizes information on prerequisites and other background information for each of the **undergraduate upper level courses** in the Department. The following information is intended to assist the student in the selection of courses in the upper class years.

228 Energy Solutions for the Next Century – MAE 228 is an optional core requirement in the Sustainable Energy Program recommended for AB students. This course is open to Engineering and Liberal Arts Majors. Course will not serve as a Technical Elective.

305 Mathematics in Engineering I (Ordinary Differential Equations) - requires MAT 201 and MAT 202 as prerequisites with the possibility that MAT 202 may be taken concurrently. This course should be taken as early as possible in the student's program. **Required for all Mechanical and Aerospace Engineering majors.**

306 Mathematics in Engineering II (Partial Differential Equations and Complex Variables) - requires MAE 305 as an absolute prerequisite. This course satisfies the second mathematics requirement in the department and in the Engineering Physics Program and is ***recommended for those planning to go to graduate school in engineering or applied science.***

321/322 Engineering Design/Mechanical Design-MAE 321 is a prerequisite for MAE 322. **MAE 321 is required for all Mechanical and Aerospace Engineering students. Either MAE 322, MAE 412 or MAE 416 is required for all Mechanical Engineering students.**

323 Aerospace Structures - The course presents contemporary methods of mechanical and structural analysis used in Aerospace. Foundational topics covered include: equations of linear elasticity, virtual work and energy formulations, basic concepts of structural stability and vibration. An introduction to Finite Element Analysis is also presented and the students will gain familiarity with commercial Finite Element application software in the context of aerospace structures. **Either MAE 323, CEE 361, or CEE 312 is Required for all Mechanical and Aerospace Engineering majors.**

324 Structure and Properties of Materials. SEAS 1st year requirements of chemistry, physics, and math are prerequisites. **Either MAE 324 or MSE 301 is required for all Mechanical and Aerospace Engineering majors.**

325 [CEE 361]	Structural Analysis and Intro to Finite Element Methods – requires only sophomore Modern Solid Mechanics (MAE 223). **Either MAE 323. CEE 361 or CEE 312 is required of all Mechanical and Aerospace Engineering students**.
331/332	Aircraft Flight Dynamics/Aircraft Design - Requires the sophomore curriculum. Simultaneous enrollment in Fluid Dynamics (MAE 335) is desirable, although it is not required. **Required for Aerospace Engineering majors.** **Optionally, MAE 341/342 may be taken to satisfy this requirement. (MAE 331/332 and MAE 341/342 are offered in alternate years.)**
335	Fluid Dynamics - requires only the sophomore curriculum as a prerequisite and Mathematics in Engineering I (MAE 305) as a co-requisite. **Required for Aerospace Engineering majors. Either MAE 335 or MAE 423 is required for all Mechanical Engineering students.**
339/340	Junior Independent Work - Students may wish to complete a one term independent work project during their junior year. Students develop a topic of their own or select from a list of topics prepared by the faculty. They develop a work plan and select an adviser and a second reader. Registration for the course is accomplished at normal course selection time, while topic and advisor can be selected at any time prior to the end of the first two weeks of the appropriate semester. *These courses do not satisfy the senior independent work requirement of the department.*
339D/340D	Junior Independent Work with Design - Independent work with design is intended for juniors who wish to complete a one term project. Similar to 339/340, with the principal difference that the project must incorporate aspects and principles of design in a system, product, vehicle, device, apparatus, or other design element. Registration for the course is accomplished at normal course selection time, while topic and advisor can be selected at any time prior to the end of the first two weeks of the appropriate semester. *These courses do not satisfy the senior independent work requirement of the department.*
341/342	Space Flight/Space System Design – MAE 341 requires Calculus and MAE 305 or permission of instructor. MAE 342 requires MAE 305 and MAE 341 is recommended. **Required for Aerospace Engineering majors.** **Optionally, MAE 331/332 may be taken to satisfy this requirement. (MAE 331/332 and MAE 341/342 are offered in alternate years.)**
344	Biomechanics and Biomaterials: From Cells to Organisms – MAE 344 requires MAT 103, MAT 104, PHY 103 and PHY 104 or permission of instructor. 344 is an optional technical elective in the Mechanical Program.
345	Introduction to Robotics – MAE 345 is an optional core requirement of the Robotics and Intelligent Systems Program. This course requires MAT 201 or 203, MAT 202 or 204, COS 126. Recommended: an introductory course in probability (ORF 309 or similar), and an introductory course in differential equations (MAE 305 or similar). 345 is an optional technical elective in the Mechanical Program.

354 Unmaking the Bomb: Science and Technology of Nuclear Nonproliferation, Disarmament, and Verification – MAE 354 is an optional technical elective in the Mechanical Program. This course requires PHY 101 or PHY 102 or PHY 103 or PHY 104. MAE 305 or permission of instructor.

412 Microprocessors for Measurement and Control - requires MAE 221 and MAE 224, or introductory knowledge of analog and digital electronics. **Either MAE 322, MAE 412 or MAE 416 is required for all Mechanical Engineering students.**

416 Bioinspired Design - For MAE Undergraduates MAE 321 preferred. Non-MAE Undergrads: Permission from Instructor. **Either MAE 322, MAE 412 or MAE 416 is required for all Mechanical Engineering students.**

418 Virtual and Augmented Reality for Engineers, Scientists, and Architects. Prerequisites: Basic understanding of computer programming principles and familiarity with software/hardware is highly recommended. Some experience with Unreal Engine (C++, Blueprint) and Blender is recommended but not required.

421 Optics and Lasers: Building and Understanding Optical Systems: The course introduces fundamentals of optics, lasers, and Fourier transforms through lectures and hands-on activities. The topics include ray and wave optics, imaging and image processing, optical Fourier transforms, principles of lasers, and applications in nuclear fusion for renewable energy, environmental sensing, space exploration, ultrafast metrology, chemistry, and physics.

422 Introduction to the Electricity Sector – requires MAT 103 or above. ENE/MAE [ENE 422] 422 is an optional technical elective in the Mechanical Program.

423 Heat Transfer - requires the standard sophomore curriculum and MAE 305 as a co-requisite. **Either MAE 423 or MAE 335 is required for all Mechanical Engineering students**.

426 Rocket and Air-Breathing Propulsion Technology – Prerequisites: MAE 221 and MAE 222. **Either MAE 426 or MAE 427 is required for all Aerospace Engineering students.**

427 Energy Conversion and the Environment: Transportation Applications - requires only the sophomore prerequisites. **Either MAE 427 or MAE 426 is required for all Aerospace Engineering students.**

432 Deep Learning and Physical Systems - This course provides an introduction to the application of deep learning to physical problems. Topics include convolutional neural networks, and graph neural networks.

433 Automatic Control Systems - Mathematics in Engineering I (MAE 305) in addition to sophomore curriculum is a prerequisite. **Required of all Mechanical and Aerospace Engineering students**.

434 Modern Control - A useful complement or alternative to MAE 433, treating more advanced topics in control system design. MAE 433 is a prerequisite. 434 is an optional technical elective in the Mechanical Program.

438 Electrochemical Engineering - requires a background in thermodynamics.

439/440 Senior Independent Work – Senior independent work is intended for seniors who choose to complete a one term project. The independent work must incorporate aspects and principles of design, whether for a system, product, vehicle, device, software, or apparatus. Students develop a topic of their own or select from a list of topics prepared by the faculty. They develop a work plan and select an adviser. ***Either of these courses will satisfy the department's senior independent work requirement.***

442 Senior Thesis (Spring) - The senior thesis is an independent study for individual students. The thesis must incorporate aspects and principles of design, whether for a system, product, vehicle, device, software, or apparatus. Work begins in the fall, but enrollment is only in spring term when a double grade is awarded. Students develop their own topic or select a topic from a list of topics prepared by the faculty. Students develop a work plan and select an advisor for their work. ***This course will satisfy the department's senior independent work requirement.***

444 Senior Project (Spring) - The senior project is a year long independent study intended for students who choose to work in teams of two or more. The team or group project must incorporate aspects and principles of design, whether for a system, product, vehicle, device, software, or apparatus. Work begins in the fall, but enrollment is only in spring term when a double grade is awarded. Groups develop their own topic or select a topic from a list of topics prepared by the faculty. Groups develop a work plan and select an advisor for their work. ***This course will satisfy the department's senior independent work requirement.***

463 Instabilities in Fluids: Linear and Non-linear Analysis of Waves and Patterns in the Environment - MAE 463 is an optional technical elective in the Mechanical Program. This course requires 1st year Physics, 1st year Mathematics and MAE 305. (MAE 305 may be taken concurrently with the Instructor's permission).

B. Standard Sophomore Curriculum

The recommended sophomore curriculum is common to all Departmental students, except Engineering Physics students who are allowed certain substitutions (see Section F). Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/
(T.E. = Technical Elective) (N.T.E. = Non-Technical Elective)

SOPHOMORE YEAR

Option 1

FALL***
- Mathematics
- MAE 223 Modern Solids Mechanics
- MAE 221 Thermodynamics
- N.T.E. or MAE 305
- N.T.E

SPRING
- Mathematics
- MAE 206 Introduction to Engineering Dynamics*
- MAE 222 Mechanics of Fluids
- MAE 224 Laboratory
- N.T.E

Option 2

FALL***
- Mathematics
- MAE 223 Modern Solids Mechanics
- MAE 221 Thermodynamics
- N.T.E. or MAE 305
- N.T.E

SPRING
- Mathematics
- MAE 321 Engineering Design**
- MAE 222 Mechanics of Fluids
- MAE 224 Laboratory
- N.T.E.

Option 3

FALL***
- Mathematics
- MAE 223 Modern Solids Mechanics
- MAE 221 Thermodynamics
- N.T.E. or MAE 305
- N.T.E

SPRING
- N.T.E
- MAE 206 Introduction to Engineering Dynamics*
- MAE 321 Engineering Design**
- MAE 222 Mechanics of Fluids
- MAE 224 Laboratory

*MAE 206 is required for Mechanical Engineers only.
**Note that MAE 322 requires MAE 321.
It is ok to defer MAE 305 to the junior year but is strongly recommended to take sophomore year especially if you are planning to take MAE 341 and the course is being offered during your junior year. Plan ahead if deferring 206 or 321.

The School of Engineering and Applied Science computer programming requirement must be satisfied by the end of the Sophomore Year.

Some sample programs are presented to indicate the major options within the Department

***Note that the course load for this recommended curriculum (5 courses each semester) is heavier in the fall than in the spring. This is because MAE 221 has a laboratory component, whereas MAE 222 does not. Instead, the laboratory experience in the spring is listed as a separate course, MAE 224. The time commitment for MAE 224 is about one-half of a regular course. Therefore, the course load in the fall is effectively 5 ½ courses, whereas the course load in the spring is about 4 ½ courses. The course grade in MAE 224 is determined from the laboratory coursework from both the fall and spring terms.

C. Mechanical Engineering Degree

Required courses for the Mechanical Engineering Degree:

Sophomore Requirements:

- MAE 206 Introduction to Engineering Dynamics
- MAE 221 Thermodynamics
- MAE 222 Mechanics of Fluids
- MAE 223 Modern Solid Mechanics
- MAE 224 Integrated Engineering Science Laboratory (Lab course for both MAE 221 & 222)
- MAE 305 Mathematics in Engineering

Eight upper class departmental required courses:

1st Design:

- MAE 321 Engineering Design

2nd Design: One of the following courses fulfills the requirement

- MAE 322 Mechanical Design ***or***
- 412 Microprocessors for Measurement and Control ***or***
- 416 Bioinspired Design

Structures: One of the following courses fulfills the requirement

- MAE 323 Aerospace Structures ***or***
- CEE 312 Statics of Structures ***or***
- CEE 361 Matrix Structural Analysis and Introduction to Finite-Element Methods

Materials:

- MAE 324 Structure and Properties of Materials ***or***
- MSE 301

Controls:

- MAE 433 Automatic Control Systems

Thermo-Fluids: One of the following courses fulfills the requirement

- MAE 423 Heat Transfer

Independent Work – 3rd Design: One of the following courses fulfills the requirement

- MAE 497 (One-semester Senior Independent Work taken either fall or spring) ***or***
- MAE 498 in the fall and 499 in the spring (Individual Senior Thesis – together fulfill a year-long thesis) ***or***
- MAE 498G in the fall and 499G in the spring (Group Senior Thesis Project- together fulfill a year-long thesis)

Technical Elective: one course needed

Suggested Technical Electives (others can be approved by DUS)

- MAE 331 Aircraft Flight Dynamics
- MAE 341 Space Flight
- MAE 322 Mechanical Design
- COS 217 Introduction to Programming Systems
- COS 226 Algorithms and Data Structures
- ECE 206 Contemporary Logic Design
- MAE 426 Rockets and Air-Breathing Propulsion Technology
- MAE 332 Aircraft Design
- MAE 342 Space System Design
- ECE 203 Electronic Circuit Analysis, Design and Implementation
- MAE 344 Biomechanics and Biomaterials
- MAE 345 Introduction to Robotics
- ECE 346 Intelligent Robotic Systems
- MAE 427 Energy Conversion and the Environment: Transportation Applications
- MAE 434 Modern Control
- MAE 228 Energy Technology in the 21st Century
- ENE 422 Introduction to the Electricity Sector-Engineering, Economics and Regulations

SAMPLE:

Mechanical Degree Track	
Sophomore Fall	**Sophomore Spring**
MAE 221	MAE 321
MAE 223	MAE 206
MAE 305	MAE 222
HIS 225	MAE 224
PHI 202	THR 385
Junior Fall	**Junior**
AAS 201	COS 217
MAE 322	MAE 323
MAE 324	ENE 422
MAE 433	GER 211
SPI 365	
Senior Fall	**Senior Spring**
MAE 423	ECE 304
MAE 421	MUS 350
MAE 345	MAE 426
MAE 498 or 498G	MAE 499 or 499G

Students desiring an emphasis on analysis of the dynamics and control of engineering devices can follow the **Dynamics Systems** Option. Students desiring an emphasis on power generation and conversion can elect to follow the **Energy Sciences** Option. Students desiring an emphasis on design can follow the **Design** Option. It is, however, not necessary to rigidly follow either of these options as long as the requirements in Section II are satisfied.

1. **Dynamic Systems (Program include courses typically selected from the following list. Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/**

- MAE 433 Automatic Control Systems
- MAE 322 Mechanical Design
- MAE 324 Structure and Properties of Materials
- CEE 361 Matrix Structural Analysis and Introduction to finite-Elements Methods
- MAE 335 Fluid Dynamics
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 345 Introduction to Robotics
- MAE 416 Bioinspired Design
- MSE 301 Materials Science and Engineering
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 321 Engineering Design
- MAE 206 Introduction to Engineering Dynamics
- MAE 423 Heat Transfer
- MAE 438 Electrochemical Engineering
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 412 Microprocessors for Measurement and Control

2. **Energy Sciences (Program include courses typically selected from the following list. Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/**

- MAE 433 Automatic Control Systems
- MAE 324 Material Science and Engineering
- CEE 361 Matrix Structures Analysis and Introduction to finite-Elements
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 322 Mechanical Design
- MAE 416 Bioinspired Design
- Senior Independent Work or Senior Thesis or Senior Project
- Fluid Dynamics
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 321 Engineering Design
- MAE 427 Energy Conversion and the Environment: Transportation Applications
- MAE 412 Trains
- MAE 423 Heat Transfer
- MAE 438 Electrochemical Engineering
- Senior Independent Work or Senior Thesis or Senior Project

3. Design (Program include courses typically selected from the following list. Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/

- MAE 433 Automatic Control Systems
- CEE 361 Matrix Structural Analysis and Introduction to finite-Elements Methods
- MAE 324 Structure and Properties of Materials
- MAE 339D Independent Work with Design
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 345 Introduction to Robotics
- MAE 322 Mechanical Design
- MAE 416 Bioinspired Design
- MSE 301 Materials Science and Engineering
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 340D Independent Work with Design
- MAE 321 Engineering Design
- MAE 423 Heat Transfer
- MAE 438 Electrochemical
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 412 Microprocessors for Measurement and Control

Please note: Most required courses have an option to take fall or spring this will allow the student to take N.T.E. the opposite semester.

4. General Mechanical Engineering

Students not wishing to specialize in any one of the areas above (1, 2, or 3) can select any mix of the three sample curricula, provided they meet the requirements stated in Section II. These are sample programs. You do not need to follow these as indicated.

D. Aerospace Engineering Degree

Required Courses for the Aerospace Engineering Degree:
***MAE 206 Dynamics is not required but recommended**

Sophomore Requirements:

- MAE 221 Thermodynamics
- MAE 222 Mechanics of Fluids
- MAE 223 Modern Solid Mechanics
- MAE 224 Integrated Engineering Science Laboratory (Lab course for both MAE 221 & 222)
- MAE 305 Mathematics in Engineering

Nine upper class departmental require courses:

1st Design:

- MAE 321 Engineering Design

Dynamics: One of the following courses fulfills the requirement (sequence offered every other year)

- MAE 331 Aircraft Flight Dynamics ***or***
- MAE 341 Space Flight

2nd Design: One of the following courses fulfills the requirement (sequence offered every other year)

- MAE 332 Aircraft Design ***or***
- MAE 342 Space System Design

Structures: One of the following courses fulfills the requirement

- MAE 323 Aerospace Structures ***or***
- CEE 312 Statics of Structures ***or***
- CEE 361 Matrix Structural Analysis and Introduction to Finite-Element Methods

Materials:

- MAE 324 Structure and Properties of Materials ***or***
- MSE 301

Propulsion:

- MAE 426 Rocket and Air-Breathing Propulsion Technology ***or***
- MAE 427 Energy Conversion and the Environment Transportation Applications

Controls:

- MAE 433 Automatic Control Systems

Thermo-Fluids:

- MAE 335 Fluid Dynamics

Independent Work – 3rd Design: One of the following courses fulfills the requirement

- MAE 497 (One-semester Senior Independent Work taken either fall or spring) ***or***
- MAE 498 in the fall and 499 in the spring (Individual Senior Thesis – together fulfill a year-long thesis) ***or***
- MAE 498G in the fall and 499G in the spring (Group Senior Thesis Project- together fulfill a year-long thesis)

SAMPLE:

Aerospace Degree Track	
Sophomore Fall	**Sophomore Spring**
AST 250	AST 251
MAE 221	MAE 222
MAE 223	MAE 224
MAE 305	MAE 321
VIS 263	THR 385
Junior Fall	**Junior**
COM 351	ART 214
MAE 322	ENG 275
MAE 324	MAE 426
PSY 254	MAE 323
REL 280	NEU 202
Senior Fall	**Senior Spring**
MAE 335	MAE 342
MAE 341	PSY 255
MAE 433	CLA 226
MAE 498 or 498G	MAE 499 or 499G

Students wishing to concentrate their study on vehicles in air and space follow the curriculum in Aerospace Engineering (see Section II for required courses). Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/
A typical program is listed below:

- MAE 433 Automatic Control Systems
- MAE 3X1 Flight Dynamics
- CEE 361 Matrix Structural Analysis and Intro to Finite Element Methods
- Senior Independent Work or Senior Thesis or Senior Project
- MAE 335 Fluid Dynamics

***Note:** Either **MAE 331** Aircraft Flight Dynamics -or- **MAE 341** Space Flight – Aircraft or Space Flight must be completed in their respective sequence for credit. If MAE 331 is elected, MAE 335 should be taken concurrently and prior to MAE 426.

- MAE 3X2 Design
- MSE 301 Materials Science and Engineering
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 321 Engineering Design
- MAE 434 (or another technical elective)
- MAE 427 Energy Conversion and the Environment: Transportation Applications
- MAE 426 Rocket and Air-Breathing Propulsion Technology
- Senior Independent Work or Senior Thesis or Senior Project

***(Note:** Either **MAE 332** Aircraft Design -or- **MAE 342** Space System Design - Aircraft or Space Flight must be completed in their respective sequence for credit)

SUGGESTED TECHNICAL COURSES

MSE 302 Laboratory Techniques in Materials Science and Engineering
COS 217 Introduction to Programming Systems
COS 226 Algorithms and Data Structures
ECE 206 Contemporary Logic Design

ECE 201 Information and Signals
ECE 203 Electronic Circuit Analysis, Design and Implementation
COS 217 Introduction to Programming Systems
COS 226 Algorithms and Data Structures
MAE 434 Modern Controls
MAE 412 Microprocessors for Measurement and Control

E. Mechanical and Aerospace Engineering Degree

Required Courses for Mechanical and Aerospace Engineering Degree:

Sophomore Requirements:

- MAE 206 Introduction to Engineering Dynamics
- MAE 221 Thermodynamics
- MAE 222 Mechanics of Fluids
- MAE 223 Modern Solid Mechanics
- MAE 224 Integrated Engineering Science Laboratory (Lab course for both MAE 221 & 222)
- MAE 305 Mathematics in Engineering

Ten upper-class departmental require courses:

1st Design:

- MAE 321 Engineering Design

2nd Design:

- MAE 322 Mechanical Design ***or***
- MAE 412 Microprocessors for Measurement and Control ***or***
- MAE 416 Bioinspired Design

Dynamics: One of the following courses fulfills the requirement (sequence offered every other year)

- MAE 331 Aircraft Flight Dynamics ***or***
- MAE 341 Space Flight

3nd Design: One of the following courses fulfills the requirement (sequence offered every other year)

- MAE 332 Aircraft Design ***or***
- MAE 342 Space System Design

Structures: One of the following courses fulfills the requirement

- MAE 323 Aerospace Structures ***or***
- CEE 312 Statics of Structures ***or***
- CEE 361 Matrix Structural Analysis and Introduction to Finite-Element Methods

Materials:

- MAE 324 Structure and Properties of Materials ***or***
- MSE 301

Propulsion:

- MAE 426 Rocket and Air-Breathing Propulsion Technology ***or***
- MAE 427 Energy Conversion and the Environment Transportation Applications

Controls:

- MAE 433 Automatic Control Systems

Thermo-Fluids:

- MAE 335 Fluid Dynamics

Independent Work – 4rd Design: One of the following courses fulfills the requirement

- MAE 497 (One-semester Senior Independent Work taken either fall or spring) ***or***
- MAE 498 in the fall and 499 in the spring (Individual Senior Thesis – together fulfill a year-long thesis) ***or***
- MAE 498G in the fall and 499G in the spring (Group Senior Thesis Project- together fulfill a year-long thesis)

SAMPLE:

Mechanical and Aerospace Degree Track	
Sophomore Fall	**Sophomore Spring**
ENV 377	CLA 219
MAE 221	MAE 206
MAE 223	MAE 222
MAT 202	MAE 224
PHI 202	MAE 321
Junior Fall	**Junior**
ART 233	MAE 323
MAE 305	MAE 427
MAE 324	NEU 325
MAE 335	PSY 309
REL 280	
Senior Fall	**Senior Spring**
MAE 322	CBE 260
MAE 341	CLA 226
MAE 433	MAE 342
MAE 498 or 498G	MAE 499 or 499G

F. Engineering Physics Program

Students with a strong interest in applied science and plans for graduate study may wish to participate in the Engineering Physics Program. Students should contact the Engineering Physics Program Director when they join the Department. The program requirements include five Physics courses beyond the 1st year level (the sequence Physics 208, 305 is required), and two upper class mathematics courses (300 and 400 level). Courses sometimes shift semesters, always check course offerings here: https://registrar.princeton.edu/

- Mathematics
- PHY 207 From Classical to Quantum Mechanics
- MAE 221 Thermodynamics
- Mathematics
- PHY 301 Thermal Physics
- CEE 361 Matrix Structural Analysis and Introduction to Finite Element Methods
- MAE 433 Automatic Control Systems
- PHY 305 Introduction to the Quantum Theory
- MAE 335 Fluid Dynamics
- Begin Senior Thesis

- Mathematics
- PHY 208 Principles of Quantum Mechanics
- MAE 222 Mechanics of Fluids
- MAE 224 Integrated Engineering Science Laboratory
- Mathematics
- PHY 304 Advanced Electromagnetism
- MSE 301 Materials Science and Engineering
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 321 Engineering Design
- PHY 408 Modern Classical Dynamics
- MAE 442 Senior Thesis
- MAE 412 Trains

Engineering Physic students may take PHY 207 From Classical to Quantum Mechanics in place of MAE 223 and PHY 208 Principles of Quantum Mechanics in place of MAE 206

If **PHY 301** is completed, this course can be used to satisfy one of the engineering science requirements

SUGGESTED TECHNICAL COURSES

MAE 511	Experimental Methods
MAE 521	Optics and Lasers
MAE 523	Electric Propulsion
MAE 527	Physics of Gases
PHY 406	Modern Physics II
MAE 555	Nonequilibrium Gas Dynamics
PHY 312	Experimental Physics
MAE 434	Modern Control
MAE 427	Energy Conversion and the Environment: Transportation Applications

Note: This sample Engineering Physics program is in coordination with the Mechanical Engineering program. The Aerospace program may also be followed.

G. Materials Science and Engineering Program

Students wishing to concentrate in materials engineering may choose courses that satisfy both the Departmental course requirements for mechanical or aerospace engineering and the Minor in Materials Science and Engineering. **The program requires**:

1. One core course in materials (MAE 324, MSE 301, or CEE 364);
2. One material experimental methods course (MSE 302, MSE 505, CHM 371 or ECE 208).
3. Three additional approved courses from the materials elective list, and;
4. A two-semester senior thesis on a materials topic approved by the committee.

The Departmental program(s) require:

For the Mechanical Program only: Four engineering science courses (including one materials course), and three design courses (two taught design courses and one semester of senior independent work or two semesters of senior thesis). Senior independent work or senior thesis will satisfy the third design requirement. Specified materials science technical electives will qualify as engineering science technical electives in the Mechanical program. See list of engineering science courses on page 6 of this booklet.
Courses sometimes shift semesters, always check course offerings here:
https://registrar.princeton.edu/

A typical course sequence following the Mechanical Engineering Program and Materials Program is as follows:

- MAE 221 Thermodynamics
- Mathematics
- MAE 324 Structure and Properties of Materials
- MAE 223 Modern Solid Mechanics
- MAE 305 Math in Engineering I
- MSE 302 Materials Lab
- MAE 335 Fluid Dynamics
- MAE 433 Automatic Control Systems
- CBE 415 Polymers
- MAE 322 Engineering Design
- Begin Senior Thesis
- MAE 206 Intro to Engineering Dynamics
- MAE 321 Engineering Design
- MAE 222 Fluid Mechanics
- MAE 224 Integrated Engineering Science Laboratory
- MAE 412 Microprocessors for Measurement and Control
- MAE 323 Aerospace Structures
- CEE 312 Statics of Structures
- MAE 423 Heat Transfer
- MAE 438 Electrochemical Engineering
- MAE 442 Senior Thesis
- CEE 361 Matrix Structural Analysis and Introduction to Finite-Element Methods

NOTE: Those students wishing to follow the Aerospace Engineering Program should consult with their Academic Advisor or Departmental Representative for careful selection of technical electives. For the Aerospace Program MAE 331/332 Flight Dynamics and Aircraft Design –or- MAE 341/342 Space Flight and

Space Craft Design are required as well as MAE 427 Energy Conversion and the Environment: Transportation Applications or MAE 426 Rocket and Air-Breathing Propulsion Technology. MAE 335 Fluid Dynamics must be taken in a fall semester in lieu of MAE 423 Heat Transfer.
For students completing both the Mechanical and Aerospace Engineering Programs three taught design courses are required (MAE 321 Engineering Design, a Mechanical Design Course, and an Aerospace Design course) as well as senior independent work or senior thesis.

SUGGESTED TECHNICAL COURSES:

One of the attractive features of the program is the opportunity to choose a focus in a particular area of materials science and engineering that is of special interest to the student. For example, students may choose electives in the areas of: micro-and nano-scale materials science and engineering; biomedical materials and bioengineering, materials modeling, or structural materials.

Other areas of concentration may also be developed, depending on student interest. The technical electives may be selected from the list of courses shown below. Students may also consider to taking graduate level courses for technical electives.

Approved Undergraduate Courses in Materials Science and Engineering:

CHM 303/304 Organic Chemistry
CHM 305/306 Physical Chemistry
CHM 406 Advanced Physical Chemistry
CHM 407/408 Inorganic Chemistry
CBE 415 Polymers
CBE 421 Catalytic Chemistry
ECE 341 Solid-State Devices
ECE 342 Principles of Quantum Engineering
ECE 351 Electromagnetic Field Theory and Physical Optics
ECE 352 Physical Optics
ECE 441/442 Solid-State Physics I, II
ECE 453 Optical Electronics
MAE 324 Structure and Properties of Materials
MAE 344 Biomechanics and Biomaterials: From Cells to Organisms
PHY 304 Advanced Electromagnetism
PHY 305 Introduction to Quantum Theory

H. Interdepartmental Programs

1. Minor in Computer Science

Students with interests in computer science may use upper class electives to satisfy the requirements of this program. Students should contact the COS Minor Program Director for specific details; see Section VIII.

2. Minor in Applied and Computational Mathematics

Students with interests in applied mathematics may use upper class electives to satisfy program requirements in Applied and Computational Mathematics. Students should the contact PACM Minor Program Director for further details; see Section VIII.

3. Program in Engineering Biology

Students interested in engineering biology may use upper class electives to satisfy the requirements of this program. Students should contact the EB Program Director for specific details; see Section VIII.

4. Program in Optimization and Quantitative Decision Science

Students with a strong interest in the systems and management aspect of an engineering career may combine Departmental courses with the requirements of the certificate Program in Optimization and Quantitative Decision Science and Optimization, formerly the certificate Program in Engineering and Management Systems. Those wishing to pursue this program should see the OQDS Program Director (see Section VIII) early in their academic career. A number of the program requirements satisfy Departmental requirements as well.

5. Minor in Engineering Physics

Students interested in engineering physics may use upper class electives to satisfy the requirements of this program. There are also pre-approved substitutions in the sophomore level MAE requirements for students participating in this program (see page 18). Students should contact the EP Program Director for specific details of the program; see Section VIII.

6. Minor in Materials Science and Engineering

Students interested in materials science and engineering may use upper class electives to satisfy the requirements of this program. Students should contact the MSE Minor Program Director for specific details; see Section VIII.

7. Minor in Robotics

Students interested in robotics and intelligent systems may use upper class electives to satisfy the requirements of this program. Students should contact the Robotics Minor Program Director for specific details; see Section VIII.

8. Minor in Sustainable Energy

Students interested in sustainable energy may use upper class electives to satisfy the requirements of this program. **S**tudents should contact the PSE Program Director for specific details; see Section VIII.

Sufficient flexibility is present in the Department Program to permit students to participate in other certificate programs such as the one offered by the Woodrow Wilson School.

IV. DEPARTMENTAL PRIZES

Six Departmental prizes are awarded each year at Class Day.

THE GEORGE BIENKOWSKI PRIZE*:* This is a financial award given in honor of George Bienkowski, former Professor and Undergraduate Representative. This award is given to a senior student(s) of sound academic standing and who has contributed to the department and engineering through their service during their career at Princeton.

THE JOHN MARSHALL II MEMORIAL PRIZE*:* This prize provides financial support for undergraduate independent work with preference given to projects in aerospace engineering. The prize is given in memory John Marshall II, '72. Prize winners are selected by the Undergraduate Faculty Committee based on written proposals submitted early in the fall. Additionally, a prize will be awarded in spring.

DONALD JANSSEN DIKE AWARD FOR EXCELLENCE IN UNDERGRADUATE RESEARCH*:* In memory of Donald Janssen (D.J.) Dike, '51. This financial award is presented to a senior(s) who in the opinion of the faculty have excelled in independent work.

SAU-HAI LAM *58 PRIZE IN MECHANICAL AND AEROSPACE ENGINEERING
Established by a donation from Professor Sau-Hai Lam, an emeritus faculty member, to the Mechanical and Aerospace Engineering Department, this prize was established to recognize graduating seniors and possibly juniors for their outstanding academic achievement.

MORGAN W. McKINZIE '93 SENIOR THESIS FUND AND PRIZE
In memory of Morgan W. McKinzie '93. The Senior Thesis fund provides financial support for independent work with preference given to projects in aircraft design and propulsion. The Senior Thesis prize is a financial award for the best Senior Thesis in the MAE Department as determined by the faculty.

ENOCH J. DURBIN PRIZE FOR ENGINEERING INNOVATION
This prize, established in memory of faculty emeritus Enoch J. Durbin, is awarded to a senior in the Department where independent work or thesis has shown special interest and aptitude in engineering innovation.

V. INDEPENDENT WORK AND STUDENT PUBLISHED PAPERS

A good indication of the interest of students in the MAE Department is the independent work they have chosen. Topics for the Class of 2025 are given below.

Class of 2025 Senior Thesis Individual Projects

Ahmad, Fawaz: Parametric Study of Aft Rotor Optimization in Stacked Propeller Systems for Urban Air Mobility

Alavi, Shayan: Respiration System Design For A Titan Spacesuit

Altomare, Mariana: Feather-Inspired Control: Modeling the Aerodynamic Forces on a Passive Control Surface

Arrington, Ethan: WingSpan: A Novel Expanding Wing Design for Enhanced SAR Versatility

Ambaw, Joachim: FinMotion: Bio-Inspired Locomotion for the BlueKoi Robotic Fish

Bae, Sidney: Fish Out of Water: Enabling a Flying Fish Robot to Taxi to Study the Effect of an Asymmetric Caudal Fin on Multi-Medium Locomotion

Chun, Fiona: Close Proximity Spacecraft Rendezvous Simulation via Omnicoptor

Coulibaly, Med: Laser Ablation Propulsion in the Martian Environment

Cueva, Emma: Exploration of Thermocapillary Movement of Bubbles in Narrow Cylindrical Tubes

Dheekollu, Harsha: Potential Viability of Air-cooled Phase Change Materials as an Alternative Thermal Management System for EV Batteries

Even, Hannah: Investigation of Active Site Environment of Zeolite-Supported and Encapsulated Palladium Nanoparticles for Methane Partial Oxidation to Methanol by Hydrogen Peroxide

Frudit, Helena: A high-resolution bioenergy sector optimization model for Brazil

Graham, Mikey: Utilizing Solid-State Cooling to Improve Workout Performance

Graves-Wake, Gabby: Hockey Puck Launcher

Harbers, Luc: Design and Assessment of a Standalone Continuous Toroidal Electromagnet for Novel Stellarator Concepts

Hutto, Julia: TKO Off-Grid Power Module

Inman, Callum: 3D Locomotion and Autonomous Navigation in OSCAR: Advancing Origami-Enabled Mobile Robots for Complex Terrain Traversal

Kim, Ben: Multifaceted Development of Vibration and Shock Testing Capabilities for In-House Spaceflight Hardware Qualification and External Stakeholder Support

Kojic, Adin: PLAV: A Python 6 Degree-of-Freedom Flight Simulator with Real-Time Arduino Hardware

in Loop Simulation

Koniaris, Zoe: Direct to the Red Planet? The Viability of Human Mars Missions Without Lunar Proving Grounds

Kreutzer, Albert: From Atomkraft to Abschaltung: The Reactivation Potential of German Nuclear Power Plants

Nucci, Giovanna: Heat Extraction by Packed Beds Constrained by Neutron Shielding Requirements and Radio Frequent Plasma Heating: An Application to Aneutronic Fusion Reactions

Ono, Mori Robin: Design and Optimization of a Self-Expanding Lunar Factory: System Architecture and Resource Utilization Modeling

Ruiz, Frida: Robo Tropical: An Autonomous Robot System for Reforestation in Water Logged Sites

Sanchirico, Amelia: Laser Fabrication of Polymer-Based Mechanical Sensors Through Simultaneous Curing and Graphitization

Stein, Noah: Design and Aerodynamic Optimization of a Rear Wing with a Drag Reduction System for a Formula Hybrid Racecar

Thompson, Laura: Numerical Study of Rotating Detonation Engines: A Discrete Inlet Flow-Field Analysis and Performance Evaluation with Varying Hydrogen and Methane Fuel Composition

Tran, Jimmy: Integration and Testing of Planner Methods on AgIRoM: An Agile Vision-based UAV Platform

Ushizima Sabino, Iris: Toward a Novel Approach for Multimodal Combustion Simulations in Reactivity-Controlled Compression Ignition Engines

Vogeley, Raphael: Surface Nitriding and Reduction of Iron and Nickel Under Direct H2 and H2/NH3 Flame Exposure

Waldman, Jasper: A Computational Design Framework for Hydrofoil Design Applied to the International Moth

Class of 2025 Senior Projects (Team or Group Projects)

Alfandre, Evan/Fu, David/ Storey-Matsutani, Mariko: Microsat Mission Design for Magnetosphere and Ring Science in the Uranian System

Crocker, Jackson/Herrera, David/Schuman, Zev: Yerf-Dog: An Autonomous Buggy

Flores, Osvaldo/Herrera, Jesus/Lin, Zayvinn: FyreFly: An Application of Aerial Surveillance for Search, Rescue, and Delivery

Robbins, Andrew/Sajid, Rihan/Solzhenitsyn, Anna: Integrated Design of a High-Performance, Low-Voltage Electric Marine Outboard with Remote Control Capabilities

Class of 2025 Senior Independent Work (One Semester Project)

Amen, Jack: Solar Flares and Satellites: Testing the Sensitivity of the Iterative Ensemble Kalman Smoother

Geisler, Carrie: Journey to a Metal World: The Search for Fossils of Magnetic Fields on 16-Psyche

Hwang, Michael: Effect of Cu2O Catalyst on CO2-HePlasma Uniformity and CO Generation

Moreira Behrens, Adrian: Practicing Detachment: A Separation Mechanism for OSCAR bots using Shape Memory Alloys

Nicacio, Sabrina: DANCING IN SPACE: Fuel-Optimal Formation Change Algorithms for Satellite Swarms

Wakatsuki, Shun: Probabilistic Wind Hazard and Economic Valuation Framework for Coastal Transmission Infrastructure Resilience: Application to Investment Thresholds Under Climate-Induced Wind Risk in Shoreline Renewable Energy Development

Independent Work Projects or Senior Thesis research may result in a published paper with the student's advisor. Here are some examples:

- "Rhythm Bots (2024): A Sensitive Improvisational Environment". N.E. Leonard, J. Cox, D. Trueman. M. Santos, K. Wantlin, I.X. Han, S. Witzman, T. James. 38th Conference on Neural Information Processing Systems (NeurIPS 2024), Creative AI Track, Vancouver, Canada. December 2024.

- "Development of Global Topology Algorithms Applied to a Lyapunov-Based Guidance Law for Low-Thrust Elliptic Keplerian Transfers". Benjamin L. Benjadol and Ryne Beeson. AAS/AIAA Astrodynamics Specialist Conference. 304. August 2024.

- "A Feasibility Study of Microsat Mission Architectures for Ring Science in the Uranian System". An-Ya Olson, Amlan Sinha, Arjun Chhabra, Sarah Fry, Kristen Ahner, Ryne Beeson, and Adarsh Rajguru. AIAA/AAS Space Flight Mechanics Meeting. January 2024.
  https://collaborate.princeton.edu/en/publications/a-feasibility-study-of-microsat-mission-architectures-for-ring-sc

- "Emergent Coordination Through Game-Induced Nonlinear Opinion Dynamics". H. Hu, K. Nakamura, K. Hsu, N. E. Leonard and J. F. Fisac. 2023 62nd IEEE Conference on Decision and Control (CDC), Singapore (Nomination for Roberto Tempo Best Paper Award). December 2023.
  https://collaborate.princeton.edu/en/publications/emergent-coordination-through-game-induced-nonlinear-opinion-dyna

- "Decentralized Learning with Limited Communications for Multi-robot Coverage of Unknown Spatial Fields". K. Nakamura, M. Santos and N. E. Leonard. IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2022. Kyoto, Japan. October 2022.
  https://collaborate.princeton.edu/en/publications/decentralized-learning-with-limited-communications-for-multi-robo

- "CO2-Driven Diffusiophoresis and Water Cleaning: Similarity Solutions for Predicting the Exclusion Zone in a Channel Flow". S. Shim, J.T. Ault, M. Baskaran, E.H. Thai and H.A. Stone. *Lab on a Chip*. September 2021.
  https://collaborate.princeton.edu/en/publications/cosub2sub-driven-diffusiophoresis-and-water-cleaning-similarity-s

- "Effect of Gravity on the Shape of a Droplet on a Fiber: Nearly Axisymmetric Profiles with Experimental Validation". A. Gupta, A.R. Konicek, M.A. King, A. Iqtidar, M.S. Yeganeh and H.A. Stone. *Physical Review Fluids.* June 2021.
  https://collaborate.princeton.edu/en/publications/effect-of-gravity-on-the-shape-of-a-droplet-on-a-fiber-nearly-axi

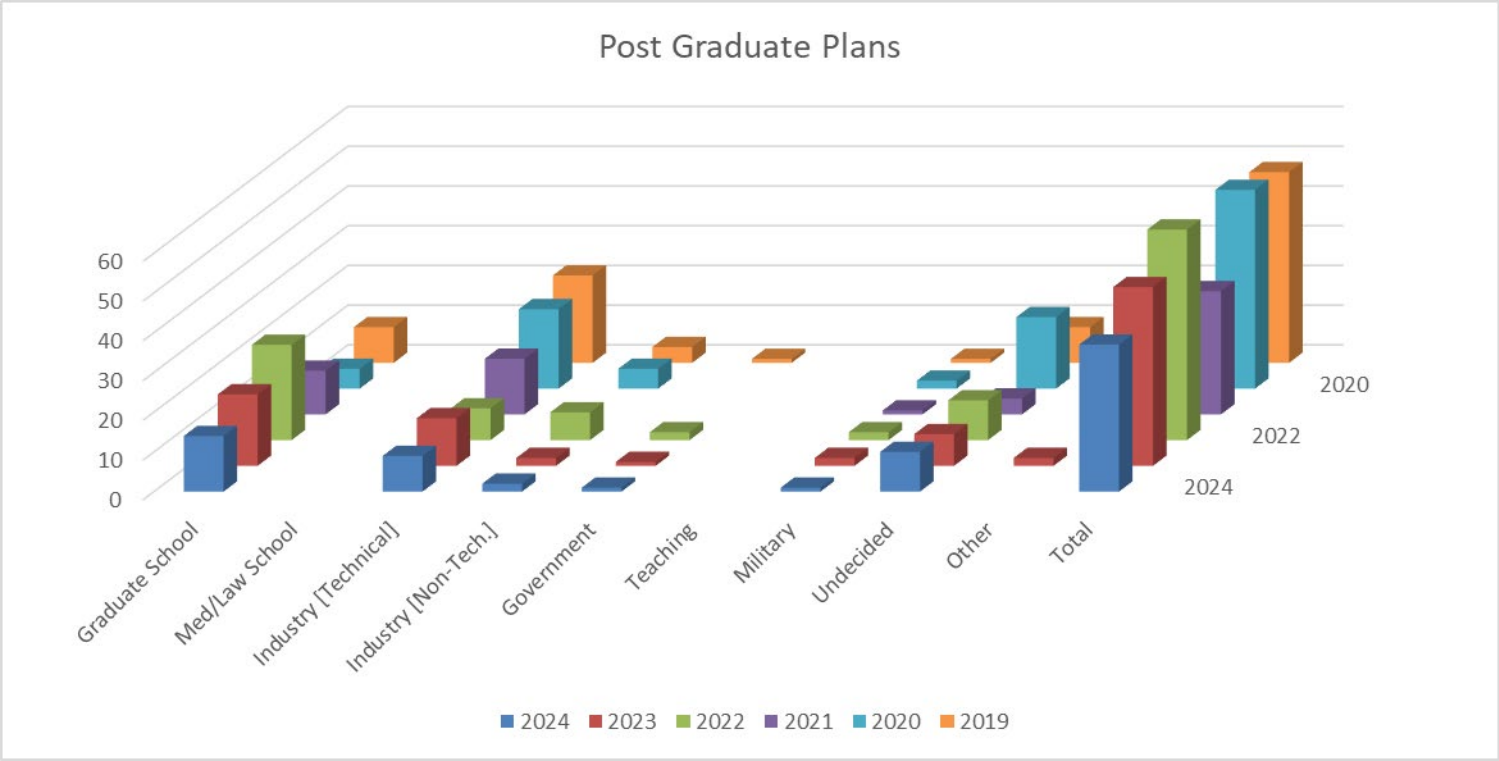
- "Flow Speed has Little Impact on Propulsive Characteristics of Oscillating Foils." T. Van Buren, Nathan Wei, D. Floryan, and A.J. Smits, *Physical Review Fluids*. January 2018.
  https://collaborate.princeton.edu/en/publications/flow-speed-has-little-impact-on-propulsive-characteristics-of-osc

- "Swimming Speed has Little Impact on Fish-Like Swimming Performance". A. Smits, N. Wei, et. al. Presented at the 69th Annual Meeting of the American Physical Society Division of Fluid Dynamics, Portland, Oregon. November, 2016.

- "Passive Boundary Layer Separation Control on a NACA2415 Airfoil at High Reynolds Numbers". A. Parikh. Presented at the 69th Annual Meeting of the American Physical Society Division of Fluid Dynamics. Portland, Oregon. November, 2016.
  https://meetings.aps.org/Meeting/DFD16/Session/G7.6
  https://collaborate.princeton.edu/en/publications/design-and-construction-of-a-76m-long-travel-laser-enclosure-for-

VI. POST-GRADUATION PLANS

An indication of the career plans of the graduates of the Department obtained from the immediate post-graduation plans of the Classes of 2019 through 2024 are charted below.



VII. FACULTY RESEARCH INTERESTS

Christine Allen-Blanchette	My work investigates the integration of physics-based constraints in deep neural network modeling with the goal of improving model interpretability and performance in previously unseen settings.
Craig B. Arnold	Research in the general area of materials synthesis and processing with interests in energy storage and conversion, additive and 3D manufacturing, microfluidics, and laser processing. Current projects include laser-induced microfluidic jetting, 3D and additive manufacturing of metal alloys, mechanics of batteries, electrochemical energy harvesting, and advanced optics for real-time 3D imaging. Research includes a mix of both experimental and theoretical projects ranging from fundamental science through product commercialization.
Ryne Beeson	In my research, I develop mathematical theory and algorithms for improvement of solutions to optimal trajectory, guidance, navigation, and estimation problems. I use theory and techniques from optimal control, optimization, numerical methods, nonlinear filtering, inverse problems, probability, information theory, machine learning, and dynamical systems. I have an interest in applications to estimation of Earth and space weather/climate (high dimensional chaotic systems with sparse sensing), automated global spacecraft trajectory optimization, spacecraft guidance and navigation, and space situational awareness.
Emily A. Carter	Development of accurate and efficient quantum mechanics simulation techniques, including embedded correlated wavefunction and orbital-free density functional theories. Discovery and design of materials for producing chemicals, materials, and fuels from renewable energy, with a specific emphasis on carbon dioxide utilization.
Edgar Y. Choueiri	Spacecraft propulsion, plasma dynamics, astronautics, space plasma physics, acoustics, 3D audio, sound perception and localization.
Daniel J. Cohen	We do a variety of bioengineering, biomechanics, and biomaterials research with living tissues and engineered micro-devices. Cells are easy and fun to work with and we will teach you what you need to know! Current projects include micro-patterning of tissues, studying the swarm behaviors of hundreds of thousands of cells as they heal injuries, building tools to apply forces and electric fields to cells, and more. Our work is highly interdisciplinary and there will be many opportunities for independent projects. Learn more about our work and projects at CohenGroup!

Luc Deike	Research focuses on multi-phase turbulent systems, involving waves, drops and bubbles in turbulent environment. We develop laboratory and numerical experiments to explore the physics at play and build simple models. Our work is motivated by environmental and industrial applications, as diverse as the statistics of waves in the ocean, wave impact on structures, floating ice sheet, gas transfer by surface breaking waves in the ocean, spray dynamics and cloud formation in the atmosphere.
Michelle DiBenedetto	Research interests are in environmental fluid mechanics, often related to waves and turbulence, and typically use laboratory experiments and theory. We are interested in how the ocean moves and mixes material, including microplastics and sea ice, and how moving animals interact with ocean flows. We also study problems related to ocean sensing and ocean energy extraction including wave energy.
Alison Ferris	Our group conducts research in three main areas: high-temperature reaction kinetics, sustainable fuel design, and novel optical diagnostic development. As an experimental lab, we use a wide range of experimental facilities (e.g., shock tube) and diagnostic approaches (e.g., laser absorption spectroscopy, FTIR, etc.) to study chemical reactions relevant to propulsion and atmospheric chemistry. Current interests include using laser-based methods and data-driven machine learning to accelerate the development of sustainable aviation fuels (SAFs), and conducting experiments to understand the atmospheric impact of emissions from SAFs and other low-carbon fuels.
Alexander Glaser	Research focuses on the technical aspects of nuclear-energy use and related fuel-cycle technologies, and specifically on questions related to the proliferation of nuclear weapons. Analyses are supported by computer simulations of reactors. Additional projects on nuclear nonproliferation and disarmament, including nuclear forensics and nuclear archaeology. Web: https://sgs.princeton.edu/the-lab
Mikko Haataja	Research focuses on theoretical and computational materials science and physical biology. Current work includes studies of microstructure formation during solid-solid phase transformations, dislocation dynamics, mechanics of bulk metallic glasses, and evolving microstructures in biology.
Kelsey Hatzell	Our group works on printable materials and understanding electrochemistry at interfaces. We also look at solution processed material synthesis of low dimensional materials for energy storage and water desalination application. We are interested in understanding far-from equilibrium material systems and utilize a suite of x-ray and neutron technique to understand these systems.

Marcus Hultmark	Research interests are in experimental and theoretical fluid mechanics. Problems involving heat, mass and momentum transfer are being studied, including atmospheric flows, wind energy and bio inspired flows. Most work involves water or wind tunnels and some involve unique instrumentation.
Jesse Jenkins	Energy systems engineer with a focus on the rapidly evolving electricity sector, including the transition to zero-carbon resources, the proliferation of distributed energy resources, and the role of electricity in economy-wide decarbonization. Jesse's research focuses on improving and applying optimization-based energy systems models to evaluate low-carbon energy technologies, policy options, and robust decisions under deep uncertainty.
Yiguang Ju	Energy conversion by using alternative fuels. Engine knock and detonation. Non-equilibrium plasma assisted combustion for propulsion and fuel reforming. Advanced laser diagnostics and imaging of combustion processes. Multi-scale modeling of combustion in propulsion systems. Synthesis of functional nanomaterials for energy storage and optical imaging.
Egemen Kolemen	Research focuses on the application of dynamics and control theory to experimental plasma physics, primarily to address the challenges of fusion reactor design. I analyze the dynamics of complex plasma phenomena using applied mathematics and control theory with the aim of designing and implementing novel control techniques, which I then use to build real-time control systems from the ground up. Current research includes reduction of the heat flux to the fusion reactor vessel using advanced magnetic divertor configuration, detachment, and radiation control; and disruption avoidance against instabilities such as Neoclassical Tearing Modes and Resistive Wall Modes.
Andrej Kosmrlj	Research combines elements of mechanics, physics and biology. Research projects include design and mechanics of metamaterials with unusual mechanical properties; biomechanics; mechanics in morphogenesis during embryo development; statistical mechanics of microscopic structures in the presence of thermal fluctuations and disorder, with potential applications for flexible electronics, sensitive force sensors or micro-actuators.
Chung King Law	Research interests include droplet and spray combustion, formulation of synthetic and high-energy fuels, flame structure studies, ignition and extinction phenomena, soot formation in flames, climatic issues including hydrogen combustion and safety, combustion synthesis of materials, laser diagnostics and numerical simulation of flames.

Naomi E. Leonard	Control and dynamics with application to movement and decision-making of technological systems, such as autonomous vehicles and robotic systems, and to natural systems, such as animals. Biology-inspired, coordinated control of multi-vehicle networks. Mobile sensor networks and environmental monitoring. Modeling and analysis of collective motion and collective decision-making in animal groups such as fish schools, honeybee swarms, and zebra herds. Decision dynamics of mixed teams of humans and robots.
Michael G. Littman	Research interest in optics and lasers, and automatic controls. Prof. Littman also supervises student projects for improving laboratory experiments and lecture demonstrations for his courses on microcomputer control, history of engineering, and motorcycle design.
Anirudha Majumdar	My research interests lie in developing algorithmic tools that push highly agile robotic systems to the brink of their hardware limits while ensuring that they operate in a provably safe manner despite uncertainty in their environment and dynamics.
Luigi Martinelli	Computational Fluid Dynamics for high Reynolds number flow on complex domains: theory, software implementation on HPC systems, and utilization. Aerodynamic shape optimization for aeronautical and marine applications. Applied Aero/Hydro dynamics for aircraft, ships, cars and wind/tidal turbines.
Julia Mikhailova	Attosecond science, generation of attosecond pulses, light-matter interaction; ultrafast optics, generation and applications of ultrashort light pulses with the controlled carrier-envelope phase; optical parametric chirped pulse amplification; high-field physics, relativistic laser-plasma interaction, relativistic high-harmonic generation, laser-driven particle acceleration, quantum optics, entanglement of quantum states, biphoton states in spontaneous parametric scattering of light, filamentation of light packets in air and solids; waveguides, nonlinear fiber optics, photonic-crystal fibers; nanowaveguide sensors.
Michael E. Mueller	Computational modeling and simulation of turbulent reacting flows. Specific interests include multi-modal turbulent combustion, pollutant emissions, and combustion-affected turbulence. Uncertainty quantification for turbulent reacting flow simulations. Numerical methods for complex geometries and algorithms for heterogeneous high-performance parallel computing. Applications to reciprocating engines, aircraft engines, and stationary gas turbines.

Radhika Nagpal	My lab studies Self-organizing Systems and Collective Artificial Intelligence; we investigate many topics on the border of Robotics, AI, and Biology. Two main areas are: (1) Biologically-inspired Robot Collectives, including novel hardware design for robot swarms, decentralized collective algorithms/theory, and global-to-local swarm programming (2) Biological Collectives, including mathematical models and field experiments with social insects and cellular morphogenesis.
Daniel M. Nosenchuck	Experimental/computational fluid mechanics and instrumentation. Active control of boundary layer instabilities and turbulence. Product design and manufacture, rapid prototyping; entrepreneurship.
Clarence Rowley	Dynamical systems modeling of fluids, both to better understand the physics of complex flows, and to control these flows. Model reduction and symmetry reduction for bifurcation analysis and control. Numerical methods, and applications of geometric methods in fluid mechanics.
Aditya Sood	Our research interests lie in the areas of nanoscale thermal transport, ultrafast science, and nanoelectronics. We enjoy building tools to visualize dynamic processes in materials to understand and control the transport of energy and matter at the nanoscale. We love studying basic phenomena that are at the heart of technological challenges in energy conversion, energy storage, and energy-efficient computing. Current research directions: laser-based thermal metrology, atomically-resolved thermometry, ultrafast X-ray & electron diffraction, energy dissipation in 2D materials, electronics thermal management, ultrafast probes of microelectronic memory devices, non-destructive imaging, ion transport in batteries.
Howard A. Stone	Research interests are in fluid dynamics, widely interpreted, and include a combination of experiment, theory, simulation and modeling. The studies are oriented towards flow problems where viscous effects are significant. The Stone group has active projects involving multiphase flows in microfluidic devices, thin film flows, high-speed imaging of flow phenomena, investigations in bioengineering such as cellular-scale hydrodynamics, formation of biofilms, etc. Many projects occur at the boundaries of traditional disciplines. Stone is also interested in various industrial applications and thinking about ways modern communications and advances in small devices (mechanical, electrical, etc.) can augment and inform traditional engineering disciplines.

Aimy Wissa	The research focus of the Bioinspired Adaptive Morphology (BAM) Lab is bioinspired locomotion. More specifically, we are interested in designing, modeling, and experimentally evaluation mechanisms and robotic systems inspired by solutions found in nature and are designed to resolve state of the art engineering challenges. Our main areas of research include bird-inspired flight, insect-scale dynamics and robots, and multi-modal locomotion strategies. Our work involves wind tunnel experiments, free flight testing under motion capturing systems, and bench-top characterizations.

FACULTY AVAILABLE FOR CONSULTATION:

Barrie S. H. Royce *(Emeritus)*	Present research is concerned with the mechanical properties of materials on the nanometer length scale. Of particular interest is the study of materials in a biological environment and MEMS structures. Mechanical testing techniques are being developed to look at elastic and plastic properties of nano- or micro-structured materials, their resistance to fatigue environments, and the effects of surface morphology on cell- material interactions.

VIII. WHO TO SEE FOR MORE INFORMATION

Normally, first year students who choose to pursue Engineering in this Department have their course selections for the Sophomore year approved by the Departmental Representatives: Professor Hatzell, Professor Hultmark, Professor Littman; and Professor Martinelli.

Sophomores are assigned an academic advisor in the fall. The advisor is available throughout the academic year to 1) discuss and advise students on course selections, etc. and 2) approve course selection score worksheets and course change forms. Students should feel free to discuss any questions related to their academic program with the Departmental Representative.

Departmental Representative:	Michael G. Littman Ext. 8-5198	D202A E-Quad mlittman@princeton.edu
Undergraduate Administrator	Theresa Russo Ext. 8-7972	D230 E-Quad tar3@princeton.edu

Student Departmental Committee and Other Student Committees:

MAE Undergraduate Student Council:

Co-Presidents:	Zoe Koniaris, koniaris@princeton.edu Sabrina Nicacio Gomes, snicacio@princeton.edu

SAE and Formula SAE (Society of Automotive Engineering): Princeton Racing Electric

Faculty Advisor:	*Luigi Martinelli,* gigi@phantom2.princeton.edu
E-mail:	pre@princeton.edu
President:	Vivian Chen, ECE '25 vivianchen@princeton.edu
Website:	https://princetonracingelectric.com/

Princeton Rocketry Club:

E-mail:	rockets@princeton.edu
Co-Presidents:	Sonal Bhatia, MAE '26 sbhatia18@princeton.edu Jake Vazquez, MAE '26 jakevazquez@princeton.edu
Website:	https://www.princetonrocketry.com/

Interdepartmental Programs (For Current Academic Year):

Minor in Applied & Computational Mathematics
Director: Amit Singer – amits@math.princeton.edu
201 Fine Hall, Phone: 8-3682

Minor in Computer Science

Director: Kevin Wayne – wayne@cs.princeton.edu
Corwin Hall Rm. 040
Program Coordinator: Laura Cerrito – lcerrito@princeton.edu
212 Computer Science Building, Phone: 8-8519

Program in Engineering Biology
Director: Celeste Nelson – celesten@princeton.edu
303 Hoyt Laboratory, Phone 8-8851

Program in Optimization and Quantitative Decision Science
Director: Amir Ali Ahmadi – aaa@princeton.edu
329 Sherrerd Hall, Phone: 8-6416

Program in Engineering Physics
Director: Waseem Bakr - wbakr@princeton.edu
381 Jadwin Hall, Phone 8-4383

Minor in Materials Science and Engineering
Director: Alejandro W. Rodriguez – arod@princeton.edu
B318 E-Quad, Phone 8-8962
Program Coordinator: Sandra Lam – sclam@princeton.edu
323 Bowen Hall, Phone: 8-6704

Minor in Robotics
Director: Szymon M. Rusinkiewicz – smr@princeton.edu
222 Computer Science Building, Phone: 8-7479
Program Coordinator: Mitra Kelly
RIS Program Administrator
Email
mkelly@cs.princeton.edu

Minor in Sustainable Energy
Director: Egemen Kolemen ekolemen@princeton.edu
D302 E-Quad, Phone: 8-9209

Study Abroad and Foreign Exchange:

Engineering is an international enterprise and American companies undertake projects on all continents. In addition, the globalization of enterprises frequently distributes the manufacturing and research activities of a company to several countries. Well-prepared engineers should, therefore, be familiar with the different cultures in which their expertise may be used. The Study Abroad program of the University provides an excellent opportunity to begin this process while obtaining credits from a foreign university that will count towards your degree program. Because the academic year follows different schedules in different countries and hemispheres, you will need to explore the most suitable time to enter such a program. It may be possible to combine a summer program in a country with at least one term of study in your discipline. In this context, some students with advanced standing have used the spring term of the sophomore year followed by summer study whereas others have used the fall term of the junior year.
Several foreign universities prefer visiting students to attend for a full academic year as their courses run through the year and the examinations occur at the end of this period.

The Department encourages students who are interested in this educational opportunity to discuss it with their advisor; the Department Undergraduate Representative, Professor Michael G. Littman; Dean Peter Bogucki of the School of Engineering and Applied Science; and Dean Gisella Gisolo, Office of the Dean of the College, Office of International Programs. You may also access the Study Abroad home page https://oip.princeton.edu/who-we-are/staff. Planning should start as early in the academic process as possible so that your degree program can be designed to accommodate this period of foreign study.

In the past few years, MAE students have studied at the University of Cape Town/South Africa, the University of Auckland/New Zealand, the University of Melbourne/Australia, the University of Sydney/Australia, Indian Institute of Technology/India, the University of Edinburgh/Scotland, University of Manchester/United Kingdom, University of Canterbury/New Zealand, and the University of Cantabria/Spain.

Foreign Exchange:
The School of Engineering and Princeton University have established two Foreign Exchange programs. MAE students have recently participated in the Oxford University Exchange Program in the United Kingdom spending their Junior year abroad. A program has also been established with CentraleSupélec in Paris which may focus on energy studies followed by a summer internship in an energy-related industry. A strong background in French is encouraged. There is also a program established with Delft University of Technology in the Netherlands and with Tsinghua University in China.

Study Abroad Contact Information:

Professor Michael G. Littman
D202A E-Quad
8-5198
mlittman@princeton.edu

Dean Peter Bogucki
C207 E-Quad
8-4554
bogucki@princeton.edu

Study Abroad Program
Office of International Programs
Louis A. Simpson International
Building, A60
8-5350
sap@princeton.edu

Study Abroad Homepage:

https://oip.princeton.edu/our-programs/study-abroad

Study Abroad Staff – Make an Appointment (button below Staff Profiles):

https://oip.princeton.edu/who-we-are/staff

APPENDIX I
REQUIREMENT FORMS

Aerospace Engineering Program

Name:				Year:			Advisor:		
HUMANITIES AND SOCIAL SCIENCE REQUIREMENTS (total of 7 required in four distinct areas)									
Distribution Area	Course #	Sem/Yr	Ck	Course #	Sem/Yr	Ck	Course #	Sem/Yr	Ck
(EC) Epist & Cogn									
(EM) Ethic & Moral									
(SA) Social Analysis									
(HA) Historical Analysis									
(LA) Literature & Arts									
(FL) Foreign Language									
(CD) Culture&Difference									

ENGINEERING SCHOOL REQUIREMENTS (total of 8 courses required or AP Credit)					
Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAT 103			PHY 103 OR 105*		
MAT 104			PHY 104 OR 106*		
MAT 201 OR 203*			CHM 201 OR 207* OR MOL 214 (2026 and beyond)		
MAT 202 OR 204*			COS 126 or ECE 115*		

For PHY Extended pathway exists, please refer to SEAS Guidelines

DEPARTMENTAL REQUIREMENTS (14 courses required)					
Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAE 221 (Thermo)			MAE 222(Fluids)		
MAE 223 (Solids)			MAE 224 Lab		
MAE 305 (Differential Eq.)					

( ) = Number of Courses Required

	Course	Semester/Yr	Course	Semester/Yr	Course	Semester/Yr
Design (3)**	**MAE 321**		**MAE 332 or 342**			
Senior IW or Thesis or Project	**MAE 439 (Fall)** **MAE 440 or 442 or 444 (Spring)**				**One Semester of independent work is required. More than one suggested.**	
Materials	**MAE 324 or MSE 301**					
Dynamics	**MAE 331 or 341**					
Fluids	**MAE 335**					
Propulsion	**MAE 426 or 427**					
Controls	**MAE 433**					
Structures	**MAE 323 or CEE 361 or CEE 312**					
Aero Requirements:	**MAE 321, MAE 331/341 or MAE 332/342, MAE 335, MAE 427/426, MAE 433, Materials,**					
Checklist	**MAE 323 or CEE361 or CEE312, Sr. IW -or- Sr. Thesis -or- Sr. Project**					

	Course	Semester/Yr	Course	Semester/Yr	Course	Semester/Yr
Free Electives/						
Additional Courses						
(Non-Tech Electives)						
Writing Requirement (1)						
Total # of Courses Must Equal 36			***Program(s):***			

****See back page for approved alternate courses – For PHY Extended pathway exists, please refer to SEAS Guidelines***

*****Third Design requirement will be satisfied by either Senior Independent Work, Senior Thesis, or Senior Project***

OUTSIDE COURSES (If Applicable)			
Princeton Equivalent Course #	Name of University	Semester & Year	Comments

Notes:

Substitutions not requiring Departmental Representative's Approval:

Math:
EGR 152 replaces MAT 104
EGR 154 replaces MAT 202
EGR 156 replaces MAT 201

Physics:
EGR 151 replaces PHY 103
EGR 153 replaces PHY 104

Chemistry:
CHM 207 Advanced General Chemistry: Materials Chemistry

NOTE: ISC 231, 232 (Fall) and ISC 233, 234 (Spring) replaces PHY 103/104, CHM 201 and COS 126

All other courses substitutions must be approved *in writing* by the Departmental Representative.

Design Courses:
MAE 321 Engineering Design
MAE 322 Mechanical Design
MAE 332 Aircraft Design
MAE 342 Space System Design
MAE 412 Microprocessors for Measurement and Control
MAE 416 Bioinspired Design
CEE 477 Engineering Design for Sustainable Development (for students participating in the Sustainable Energy Program)

Mechanical Engineering

Name:					Year:			Advisor:			
HUMANITIES AND SOCIAL SCIENCE REQUIREMENTS (total of 7 required in four distinct areas)											
Distribution Area	Course #	Sem/Yr		Ck	Course #	Sem/Yr		Ck	Course #	Sem/Yr	Ck
(EC) Epist & Cogn											
(EM) Ethic & Moral											
(SA) Social Analysis											
(HA) Historical Analysis											
(LA) Literature & Arts											
(FL) Foreign Language											
(CD) Culture&Difference											

ENGINEERING SCHOOL REQUIREMENTS (total of 8 courses required or AP Credit)					
Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAT 103			PHY 103 OR 105*		
MAT 104			PHY 104 OR 106*		
MAT 201 OR 203*			CHM 201 OR 207* OR MOL 214 (2026 and beyond)		
MAT 202 OR 204*			COS 126 or ECE 115		

For PHY Extended pathway exists, please refer to SEAS Guidelines

DEPARTMENTAL REQUIREMENTS (14 courses required)					
Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAE 221 (Thermo)			MAE 206 (Dynamics)		
MAE 223 (Solids)			MAE 222 (Fluids)		
MAE 305 (Differential Eq)			MAE 224 Lab		

Upper Level Departmental Requirements: ( ) = Number of Courses Required						
	Course	Semester/ Yr	Course	Semester/Yr	Course	Semester/Yr
Design (3) **	**MAE 321**		**MAE 322 or 412 or 416**			
Senior IW or Senior Thesis or Senior Project	**MAE 439 (Fall) MAE 440 or 442 or 444 (Spring)**				One semester of independent work is required. More than one suggested.	
Materials	**MAE 324 or MSE 301**					
Thermo-Fluids	**MAE 335 or 423**					
Controls	**MAE 433**					
Structures	**MAE 323 or CEE 361 or 312**					
Tech Elective						
Mech Requirements:	MAE 321, MAE 322/412/416, MAE 335/423, Tech Elective, MAE 433, Materials,					
Checklist	MAE 323 or CEE 361(MAE325) or CEE312, Sr. IW or Sr. Thesis or Sr. Project					
	Course	Semester/ Yr	Course	Semester/Yr	Course	Semester/Yr
Free Electives/						
Additional Courses						
(Non-Tech Electives)						
Writing Requirement (1)						
Total # of Courses Must			Programs			
Equal 36						

**See back page for approved alternate courses – For PHY Extended pathway exists, please refer to SEAS Guidelines*

***Third design requirement will be satisfied by either Senior Independent Work, Senior Thesis, or Senior Project*

OUTSIDE COURSES (If Applicable)			
Princeton Equivalent Course #	Name of University	Semester & Year	Comments

Notes:

Substitutions not requiring Departmental Representative's Approval:

Math:
EGR 152 replaces MAT 104
EGR 154 replaces MAT 202
EGR 156 replaces MAT 201

Physics:
EGR 151 replaces PHY 103
EGR 153 replaces PHY 104

Chemistry:
CHM 207 Advanced General Chemistry: Materials Chemistry

NOTE: ISC 231, 232 (Fall) and ISC 233, 234 (Spring) replaces PHY 103/104, CHM 201 and COS 126

Design Courses:
MAE 321 Engineering Design
MAE 322 Mechanical Design
MAE 332 Aircraft Design
MAE 342 Space System Design
MAE 412 Microprocessors for Measurement and Control
MAE 416 Bioinspired Design
CEE 477 Engineering Design for Sustainable Development (pre-approved as Mech Design for those students enrolled in the Sustainable Energy Program)

Technical Electives:
CBE 341 Mass, Momentum, and Energy Transport (may replace MAE 423 Heat Transfer)

Mechanical and Aerospace Engineering Programs

Name:				Year:			Advisor:		

HUMANITIES AND SOCIAL SCIENCE REQUIREMENTS (total of 7 required in four distinct areas)

Distribution Area	Course #	Sem/Yr	Ck	Course #	Sem/Yr	Ck	Course #	Sem/Yr	Ck
(EC) Epist & Cogn									
(EM) Ethic & Moral									
(SA) Social Analysis									
(HA) Historical Analysis									
(LA) Literature & Arts									
(FL) Foreign Language									
(CD) Culture&Difference									

ENGINEERING SCHOOL REQUIREMENTS (total of 8 courses required or AP Credit)

Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAT 103			PHY 103 OR 105*		
MAT 104			PHY 104 OR 106*		
MAT 201 OR 203*			CHM 201 OR 207* OR MOL 214 (2026 and beyond)		
MAT 202 OR 204*			COS 126* or ECE 115		

For PHY Extended pathway exists, please refer to SEAS Guidelines

DEPARTMENTAL REQUIREMENTS (16 courses required)

Course	Check	Semester/Yr	Course	Check	Semester/Yr
MAE 221 (Thermo)			MAE 206 (Dynamics)		
MAE 223 (Solids)			MAE 222 (Fluids)		
MAE 305 (Differential Eq)			MAE 224 Lab		

Upper Level Departmental Requirements:

( ) = Number of Courses Required

	Course	Semester/Yr	Course	Semester/Yr	Course	Semester/Yr
Design (4)**	**MAE 321 (AE/ME)**		**MAE 332/342 (AE)**		**MAE 322/412/416 (ME)***	
Senior IW -or- Senior Thesis or Senior Project	**MAE 439 (Fall) MAE 440 or 442 or 444 (Spring)**				**One Semester of independent work is required. More than one suggested.**	
Materials	**MAE 324 or MSE 301 (AE/ME)**					
Dynamics	**MAE 331/341 (AE)**					
Fluids	**MAE 335 (AE/ME)**					
Propulsion	**MAE 427/426 (AE)**					
Controls	**MAE 433 (AE/ME)**					
Structures	**MAE 323 or CEE361/312(AE/ME)**					
Aero Requirements: *Checklist*	**MAE 321, MAE 331/341 or MAE 332/342, MAE 335, MAE 427/426, MAE 433, Materials, MAE 323 or CEE361 or CEE312, Sr. IW or Sr. Thesis or Sr. Project**					
Mech Requirements: *Checklist*	**MAE 321, MAE 322/412/416, ***MAE 335/423****TE, MAE 433, Materials MAE 323 or CEE361or CEE312, Sr. IW or Sr. Thesis or Sr. Project**					

	Course	Semester/Yr	Course	Semester/Yr	Course	Semester/Yr
Free Electives/ Additional Courses *(Non-Tech Electives)*						
Writing Requirement (1)						
Total # of Courses Must Equal 36			**Program(s)**			

See back page for approved alternate courses – For PHY Extended pathway exists, please refer to SEAS Guidelines **Combined program requires a 4th design which will be satisfied with Sr. IW or Sr. Thesis or Sr. Project ***Mech Design requirement met with MAE 335 when completing Mech and Aero Engineering Program ****Aero requirements count as Technical Electives

OUTSIDE COURSES (If Applicable)			
Princeton Equivalent Course #	Name of University	Semester & Year	Comments

Notes:

<u>Substitutions not requiring Departmental Representative's Approval:</u>

<u>Math:</u>
EGR 152 replaces MAT 104
EGR 154 replaces MAT 202
EGR 156 replaces MAT 201

<u>Physics:</u>
EGR 151 replaces PHY 103
EGR 153 replaces PHY 104

<u>Chemistry:</u>
CHM 207 Advanced General Chemistry: Materials Chemistry

<u>NOTE: ISC</u> 231, 232 (Fall) and ISC 233, 234 (Spring) replaces PHY 103/104, CHM 201 and COS 126

<u>Design Courses:</u>
MAE 321 Engineering Design
MAE 322 Mechanical Design
MAE 332 Aircraft Design
MAE 342 Space System Design
MAE 412 Microprocessors for Measurement and Control
MAE 416 Bioinspired Design
CEE 477 Engineering Design for Sustainable Development (pre-approved as Mech Design for those students enrolled in the Sustainable Energy Program)

Notes