

# Mechanical and Aerospace Engineering Undergraduate Handbook

## Introduction

### Section I: Undergraduate Program in Mechanical and Aerospace Engineering

(Accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>)

The Department of Mechanical and Aerospace Engineering offers a standard Mechanical Engineering curriculum leading to a **BS degree in Mechanical Engineering**, with optional Aerospace Engineering or Energy Systems Concentration.

Students who select the Aerospace Engineering or Energy Systems concentration (for the ME degree) will be required to include in their departmental electives three courses related to the aerospace or energy fields. Details of the standard ME curriculum and aerospace or energy options are presented in Section II: The MAE Curriculum.

Starting with Class of 2018 the Mechanical and Aerospace Engineering Department offers a **BS degree in Aerospace Engineering** (specializing in Aeronautics or Astronautics) with an optional Energy Concentration.

Students who select the Energy concentration (for the AE degree) will be required to include in their departmental and technical electives three courses related to the energy field. Details of the standard AE curriculum with the energy option are presented in Section II: The MAE Curriculum.

Throughout the Mechanical Engineering and Aerospace Engineering curricula, every effort is made to fulfill the department's educational objectives, namely:

1. To educate and train students in Mechanical Engineering, or in Aerospace Engineering, in a technically sound, challenging and professional manner
2. To prepare students to enter careers ready to make positive contributions to their professions and society, or to continue on to successful graduate research and education
3. To inculcate in students the responsibilities and rewards associated with an engineering career and life-long service to the profession.

Where each student graduating from the Mechanical and Aerospace Engineering program would have demonstrated:

- (a) an ability to apply knowledge of mathematics, science, and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multi-disciplinary teams

- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

### **Design and Manufacturing Project I & II (*Mechanical Engineering*)**

Students during the senior year should register for the sequence of two courses: [650:467](#) Design and Manufacturing Project I (2cr) during Fall Semester and [650:468](#) Design and Manufacturing Project II (2cr) during Spring Semester. **Successful completion of these courses is a graduation requirement.**

#### Fall Registration:

Student should select a section from the list of available projects available on the MAE website:

<http://mae.rutgers.edu/capstone-design-project>

There is a limit of 5-8 students per section depending on the project. Once the limit is reached the section will be closed. The students in the section will constitute a group that will work together towards the design and manufacturing of the project prototype. If the section of your first preference is closed, please select your subsequent choice.

#### Spring Registration

Register for the same section as in the Fall Semester.

### **Aerospace Design Project I & II (*Aerospace Engineering*)**

Students during the senior year should register for the sequence of two courses: [650:487](#) Aerospace Design Project I (2cr) during Fall Semester and [650:488](#) Aerospace Design Project II (2cr) during Spring Semester. **Successful completion of these courses is a graduation requirement.**

#### Fall Registration:

Student should select a section from the list of available projects available on the MAE website:

<http://mae.rutgers.edu/aerospace-design-project>

There is a limit of 5-8 students per section depending on the project. Once the limit is reached the section will be closed. The students in the section will constitute a group that will work together towards the design and manufacturing of the project prototype. If the section of your first preference is closed, please select your subsequent choice.

#### Spring Registration

Register for the same section as in the Fall Semester.

# PROJECT GUIDELINES FOR DESIGN AND MANUFACTURING OR AEROSPACE DESIGN

## Description

The culmination of every Rutgers MAE student's undergraduate academic career is the yearly Design Project. All that classroom learning gets put to real-life use as small groups work under one of our faculty members to design and build a device to accomplish a preset list of goals. Students present their projects in April of each year, often on Rutgers Day. Past projects have included a mechanical fish, unmanned aerial, ground, and naval vehicles, and so much more.

During this project, students have the opportunity to work with industry members as well as our faculty, gaining experience in real-world engineering. Many of these projects can lead to new technologies or other innovations outside of academia and they help our students transition to life after graduation.

## Duration

Design and Manufacturing is a **yearlong project**, *Fall 650:467 (ME) or 650:487 (AE) and Spring 650:468(ME) or 650:488 (AE)*. In the fall semester the students will design and budget the project while in the spring semester they will build a working prototype.

## Team building

Each team is composed of **five (5) MAE students** (larger teams can be formed upon discussion with the faculty) and **one MAE faculty** member.

A group of students may form a team and target a specific project that they like or each student may register to one of the open (no special permission number, SP#, required) projects found on the website <http://mae.rutgers.edu/capstone-design-project>

Or <http://mae.rutgers.edu/capstone-design-project>

Students and advisor from other departments may join the teams upon agreement of all team members and advisors. Non-MAE student(s) will be added to the group of 5 MAE students and they may register either in the 650: 299/399/499 course(s) or can register in their department's senior design/undergraduate research course(s).

## Projects

Each faculty has project(s) that are posted on our website by the end of the second week of April. The students should select one of those projects. There are instances that the faculty and students have made arrangements prior to the spring break for certain ideas they have that they want translated to projects. These can be included in the program if the projects are finalized by the end of the spring break of Junior year so they can be cited in the website.

## Registration

The faculty may request a project to be **by special permission only** at which instance the students will have to make arrangements and meet the faculty before they register. Alternatively, the project will be open and then the students can register on a **first-come-first-serve basis**.

Your advisor should have the special permission numbers (SP#) for your group and he/she will assign them to you after you discuss the project with him/her.

*Project registration begins in May of Junior year and should be completed by end of June of Junior year.*

## Section II: MAE Curriculum

The Department of Mechanical and Aerospace Engineering offers a [Mechanical Engineering Curriculum](#) leading to a BS degree in Mechanical Engineering. All Mechanical Engineering Students have a broad selection of Departmental Electives, which can be selected according to the students' interests and career goals. The MAE Department also offers two additional concentrations in Aerospace and Energy Systems.

- 1. Standard Mechanical Engineering Curriculum:** Students following this option are required to take any 3 Departmental Electives. In addition, students take Mechanical Engineering Laboratories II (14:650:432) in the final spring semester of senior year. Students completing the requirements for this option receive a Mechanical Engineering degree/diploma.
  - *Aerospace Concentration:* Students following this concentration are required to select only Aerospace Electives<sup>1</sup> as *Departmental* Electives (3 courses). Students completing the requirements for this concentration receive an Aerospace certificate in addition to their Mechanical Engineering Diploma.
  - *Energy Systems Concentration:* Students following this Concentration are required to select only Energy Systems Electives<sup>2</sup> as *Departmental* Electives (3 courses). Students completing the requirements for this concentration receive an Energy Systems certificate in addition to their Mechanical Engineering Diploma.
- 2. Standard Aerospace Engineering Curriculum:** Students following this option are required to take the courses described in the Aerospace Engineering section below FOLLOWING CURRICULUM PERTINENT TO THEIR YEAR OF GRADATION. *That is, the transition class graduating in 2018, first Aerospace Engineers graduating from Rutgers, have an adjusted curriculum for CLASS 2018, while the students of CLASS 2019 have the permanent Aerospace Curriculum.* In addition, students take Aerospace Engineering Laboratories II (14:650:433) in the final spring semester of senior year. Students completing these requirements an Aerospace Engineering degree/diploma.

*Note that the Aerospace discipline is designated as **Aeronautical Engineering** or **Astronautical Engineering**. The difference is that **Astronautical Engineers** have to take **650:465 Orbital Mechanics** as their departmental or technical elective.*

Aerospace Engineers may elect to do the Energy Systems concentration in the following manner:

- *Energy Systems Concentration:* Students following this Concentration are required to select only Energy Systems Electives<sup>2</sup> as *Departmental* Elective (1 course) and *Technical* Electives (2 courses). Students completing the requirements for this concentration receive an Energy Systems certificate in addition to their Mechanical Engineering Diploma.

See course [objectives and descriptions](#) for further details on engineering (650) courses.

## Electives for Mechanical Engineers: Departmental, Technical, Humanities/Social Science, General

- A. Departmental Electives are 400 level mechanical engineering (650:xxx) courses that are not already required in the curriculum. Students must take 3 Departmental Electives. (Aerospace Electives<sup>1</sup>, Energy Electives<sup>2</sup>)

### Fall Electives (Annual)

401 - System Dynamics and Controls (*previously: Mechanical Control Systems*)  
449 - Aerospace Materials (*previously: Intro. to Mechanics of Composite Materials*)  
455 - Design of Mechanisms  
455 - Design of Mechanisms  
462 - Power Plants<sup>2</sup>  
474 - Alternative Energy I<sup>2</sup>  
460 - Aerodynamics<sup>1</sup>  
471 - Aircraft Flight Dynamics

### Fall Electives (Biannual)

447 - Probabilistic Models in Mechanical and Aerospace Systems (Even Years)<sup>1</sup>  
451 - Vehicle Dynamics (Odd Years)

### Spring Electives (Annual)

458 - Aerospace Structures<sup>1</sup>  
461 - Internal Combustion Engines<sup>2</sup>  
465 - Orbital Mechanics<sup>1</sup>  
478 - ME Aspects of Electronic Packaging  
477 - Alternative Energy II<sup>2</sup>

### Spring Electives (Biannual)

463 - Compressible Fluid Dynamics (Odd Years)<sup>1</sup>  
459 - Aerospace Propulsion (Even Years)<sup>1</sup>

- B. Technical Electives are those upper level technical courses appropriate for mechanical engineers. The MAE curriculum requires two (2) technical electives to be chosen from the list of this booklet. Any extra departmental electives course may be used as a technical elective. A student may take Undergraduate Research (650:299/399/499), Internship Experience (650:495), or Co-Op Experience (650:496/497), as technical electives with approval of a professor supervising the work, for up to 6 credits (see limitations and application procedure in *Section III* of this document.)
- C. Humanities/Social Science Electives are intended to serve the objectives of a broad education, and to make engineers fully aware of their social responsibilities and better able to consider related factors in the decision-making process. The CEE curriculum contains 18 credits of Humanities/Social Science Electives, which must include 355:101 Expository Writing and 220:102 Microeconomics. At least 6 credits must be at an advanced level (300 level or higher). A list of acceptable Humanities/Social Science

Electives courses is provided on the School of Engineering website at <http://soe.rutgers.edu/oas/electives>.

- D. General Electives may be almost any course taught for credit at Rutgers University qualifies as a general elective. There are, however, a few exceptions in certain subject areas. See the School of Engineering website for details: <http://soe.rutgers.edu/oas/electives>.

## MECHANICAL ENGINEERING CURRICULUM (131 CR)

### Freshman Year

160:159	Gen.Chem. for Engrs	3	160:160	Gen. Chem for Engrs.	3
160:171	Intro. Experimentation	1	440:127	Intro.Computers for Engrs	3
355:101	Expository Writing	3	640:152	Calculus for Eng'g	4
440:100	Intro. to Engineering	1	440:221*	Eng'g Mech (Statics)	3
640:151	Calculus for Eng'g	4	750:124	Analytical Physics Ib	2
750:123	Analytical Physics Ia	2	_____	Hum/Soc Elective	3
_____	Hum/Soc Elective	3			

### Sophomore Year

640:251	Multivariable Calculus	4	332:373*	Elem. of Elect. Eng'g	3M
650:231*	M.E. Comp Anal& Des.	3M	332:375*	Elem. Elect. Eng'g Lab	1M
440:222*	Eng'g Mech (Dynamics)	3	650:215*	Modern Machining	1M
750:227	Analyt. Physics IIa	3	640:244	Differential Equations	4
750:229	Analyt. Physics IIa Lab	1	650:291*	Mech. Materials	3M
_____	Hum/Soc Elective (300+)	3	750:228	Analyt. Physics IIb	3
			750:230	Analyt. Physics IIb lab	1

**Options:      Standard      Aerospace      Energy**

### Junior Year

540:343	Engineering Econ	3M	635:407	Mech. Prop. Materials	3M
640:421	Advanced Calculus	3M	650:342*	Design Mech Components	3M
650:312*	Fluid Mechanics	3M	650:351*	Thermodynamics	3M
650:350*	ME Measurements	4M	650:388*	CAD in Mech Eng'g	3M
_____	Hum/Soc Elective (300+)	3	220:102	MicroEconomics	3

### Senior Year

650:431	ME Lab I	2M	650:432/3/5	ME/Aero/Energy Lab II	2M
650:467	Engineering Projects I	2M	650:468	Engineering Projects II	2M
650:481*	Heat Transfer	3M	650:443*	Vibrations	3M
650:4__*	Dept/Aero/Energy Elec	3M	650:4__*	Dept/Aero/Energy Elec	3M
650:4__*	Dept/Aero/Energy Elec	3M	_____	Technical Elective	3
_____	Technical Elective	3	_____	General Elective	3

- ***If the The MAE courses marked with (\*) above can be taken either fall or spring semester***
- ***Technical Elective marked with (\*\*) is an MAE course then its grade counts towards the Major GPA***
- ***All MAE Departmental Electives can count for Technical Electives***

#### Aerospace Departmental Option Courses

650:401	System Dynamics & Controls; cf pg 6
650:447	Prob Models In AE Systems
650:449	Aerospace Materials; cf pg 6
650:458	Aerospace Structures
650:459	Aerospace Propulsion
650:460	Aerodynamics
650:463	Compressible Fluid Dynamics
650:465	Orbital Mechanics
650:471	Aircraft Flight Dynamics

#### Energy Departmental Option Courses

650:461	Internal Combustion Engines
650:462	Power Plants
650:474	Alternative Energy I
650:477	Alternative Energy II



**AEROSPACE ENGINEERING CURRICULUM FOR CLASS OF 2019 (132 CR)**

**Freshman Year**

160:159	Gen.Chem. for Engrs	3	160:160	Gen. Chem for Engrs.	3
160:171	Intro. Experimentation	1	440:127	Intro.Computers for Engrs	3
355:101	Expository Writing	3	640:152	Calculus for Eng'g	4
440:100	Intro. to Engineering	1	440:221*	Eng'g Mech (Statics)	3
640:151	Calculus for Eng'g	4	750:124	Analytical Physics Ib	2
750:123	Analytical Physics Ia	2	_____	Hum/Soc Elective	3
_____	Hum/Soc Elective	3			

**Sophomore Year**

640:251	Multivariable Calculus	4	332:373	Elem. of Elect. Eng'g	3
650:210*	Intro to Aerospace Eng.	3	332:375	Elem. Elect. Eng'g Lab	1
440:222*	Eng'g Mech (Dynamics)	3	650:388*	CAD in MAE	3
750:227	Analyt. Physics IIa	3	640:244	Differential Equations	4
750:229	Analyt. Physics IIa Lab	1	650:291*	Mechanics of Materials	3
_____	Hum/Soc Elective (300+)	3	220:102	MicroEconomics	3

**Junior Year**

650:342*	Design Mech Components	3	650:471	Aircraft Flight Dynamics	3
640:421*	Advanced Calculus	3	650:458	Aerospace Structures	3
650:312	Fluid Mechanics	3	650:460	Aerodynamics	3
650:350*	ME Measurements	4	650:401*	Syst Dynamics & Controls	3
650:351*	Thermodynamics	3	650:449	Aerospace Materials	3

**Senior Year**

650:431	ME/AE Lab I	2	650:433	Aerospace Lab II	2
650:487	Aerospace Design Proj I	2	650:488	Aerospace Design Proj II	2
650:439	Multiphysics Simulations	3	650:4XX	Departmental Elective	3
650:457	Spacecraft Mission Des	3	650:463	Compr Fluid Dynamics	3
___-___	Technical Elective	3	650:459	Aerospace Propulsion	3
___-___	Hum/Soc Elective (300+)	3	___-___	Technical Elective	3

- **The MAE courses marked with (\*) above can be taken either fall or spring semester**
- **All MAE Departmental Electives can count for Technical Electives**
- **Selection of three (+) courses, two as TEs and one as DE, leads to Energy Certificate**

**Departmental Electives**

650:443	Vibrations	650:474+	Alt Energy I
650:447	Probabilistic Models	650:477+	Alt Energy II
650:451	Vehicle Dynamics	650:478	ME Aspects Elec Packg
650:455	Des Mechanisms	650:481	Heat Transfer
650:461+	Int Comp Engines		
650:462+	Power Plants		
650:465	Orbital Mechanics		

## AEROSPACE ENGINEERING CURRICULUM FOR CLASS OF 2018

### Freshman Year

160:159	Gen.Chem. for Engrs	3	160:160	Gen. Chem for Engrs.	3
160:171	Intro. Experimentation	1	440:127	Intro.Computers for Engrs	3
355:101	Expository Writing	3	640:152	Calculus for Eng'g	4
440:100	Intro. to Engineering	1	440:221	Eng'g Mech (Statics)	3
640:151	Calculus for Eng'g	4	750:124	Analytical Physics Ib	2
750:123	Analytical Physics Ia	2	_____	Hum/Soc Elective	3
_____	Hum/Soc Elective	3			

### Sophomore Year

640:251	Multivariable Calculus	4	332:373	Elem. of Elect. Eng'g	3
650:231	M.E. Comp Anal & Des	3	332:375	Elem. Elect. Eng'g Lab	1
440:222*	Eng'g Mech (Dynamics)	3	650:215	Modern Machining	1
750:227	Analyt. Physics IIa	3	640:244	Differential Equations	4
750:229	Analyt. Physics IIa Lab	1	650:291*	Mechanics of Materials	3
_____	Hum/Soc Elective (300+)	3	750:228	Analyt Physics IIb	3
			750:230	Analyt Physics IIb Lab	1

### Junior Year

650:342*	Design Mech Components	3	650:471	Aircraft Flight Dynamics	3
640:421*	Advanced Calculus	3	650:350*	ME Measurements	4
650:312*	Fluid Mechanics	3	650:460	Aerodynamics	3
650:210*	Intro to Aerospace Eng.	3	650:401*	Mechanical Control Sys.	3
650:351*	Thermodynamics	3	650:388*	CAD in MAE	3

### Senior Year

650:431	ME/AE Lab I	2	650:433	Aerospace Lab II	2
650:487	Aerospace Design Proj I	2	650:488	Aerospace Design Proj II	2
650:439	Multiphysics Simulations	3	650:458	Aerospace Structures	3
650:457	Spacecraft Mission Des	3	650:463	Compr Fluid Dynamics	3
650:449	Aerospace Materials	3	650:459	Aerospace Propulsion	3
220:102	MicroEconomics	3	____-____	Hum/Soc Elective (300+)	3

- **The MAE courses marked with (\*) above can be taken either fall or spring semester**
- **All MAE Departmental Electives can count for Technical Electives**
- **May be taken as extra load in 4<sup>th</sup> year. Not required for degree for Class '18**

### Departmental Electives

650:443	Vibrations	650:465	Orbital Mechanics
650:447	Probabilistic Models	650:474	Alt Energy I
650:451	Vehicle Dynamics	650:477	Alt Energy II
650:455	Des Mechanisms	650:478	ME Aspects Elec Packg
650:461	Int Comp Engines	650:481	Heat Transfer
650:462	Power Plants		

## **TECHNICAL ELECTIVES**

Take two courses from the science/engineering courses offered by the departments below.

<b>Code</b>	<b>Dept</b>	<b>Courses</b>
105	Astrophysics	300+, 400+
115	Biochemistry	300+, 400+
117	Bioenvironmental Engineering	413, 414, 462, 468, 474, 492, 494, 495, 496
119	Biological Sciences	115, 116, 155, 408, 409
125	Biomedical Engineering	300+, 407
146	Cell Biology and Neuroscience	200+, 300+, 400+
155	Chemical and Biochemical Engineering	400+
160	Chemistry	209, 251, 300+, 400+
180	Civil and Environmental Engineering	300+, 400+
198	Computer Science	200+, 300+, 400+
216	Ecology, Evolution, and Natural Resources	240, 401, 405, 431, 454, 486
332	Electrical and Computer Engineering	226, 231/3, 252/4, 300+, 400+
375	Environmental Sciences	202, 203, 302, 303, 307, 322, 340, 346, 360, 406, 407, 411, 421, 423, 424, 430, 434, 444, 453
400	Food Science	201, 202, 301, 302, 304, 411, 419
440	General Engineering (Packaging)	301, 302, 371, 373, 378, 403, 406, 408, 419, 420, 468, 471
447	Genetics	200+, 300+ (excluding 354), 400+
460	Geology	301, 304, 306, 402, 407, 414, 418
540	Industrial and Systems Engineering	200+, 300+, 400+ (excluding 461)
628	Marine Sciences	320, 472
635	Materials Science and Engineering	200+ (excluding 206), 300+, 400+
640	Mathematics	250, 300+, 400+
650	Mechanical and Aerospace Engineering	215, 298, 299, 300+, 400+ (except 650:486)
680	Microbiology	390, 480, 481, 494
694	Molecular Biology and Biochemistry	200+, 300+ (excluding 383), 411-414
750	Physics (Physics and Astronomy)	300+, 400+ (excluding 443, 444)
776	Plant Science	242, 305
960	Statistics	211, 212, 285, 379, 381, 382, 384, 400+

Note 1: In all course above, seminars are excluded from counting for TEs

## Section III: Professional and Supplemental Programs

### Dual Degree, Double major, and Minor programs

Minors, majors, and dual degrees provide students with the opportunity to broaden skill sets outside of engineering. These programs are offered in conjunction with various other undergraduate schools at Rutgers University, including the School of Arts and Sciences and the School of Environmental and Biological Sciences. For more information about these programs, see <http://soe.rutgers.edu/oas/minors-majors>

### BS/Master's programs

There are three special joint programs offering the opportunity for engineering students to obtain a Master's degree within one calendar year of completing the baccalaureate degree requirements. Qualified School of Engineering students are eligible to apply for admission to these accelerated Master's Programs in their junior year. For more information, see <http://soe.rutgers.edu/oas/BS-Masters>

### The James J. Slade Scholars Program

In the third year, students who have maintained a 3.2 university cumulative grade-point average may apply to the undergraduate director of their major department to be admitted into the James J. Slade Scholars Program. The Slade Scholar Program honors long-time School of Engineering faculty member James J. Slade who was a noted researcher, mathematician, and professor for 36 years. His commitment to teaching, scholarly excellence, and impact on students was legendary, and continues to resonate through this prestigious research program. Each Slade Scholar prepares a plan of study under the guidance of a three-member faculty committee and the Honors Committee of the School of Engineering. The chairperson of the student's committee shall be the research thesis adviser and should be a member of his or her major department. For more information, see <http://soe.rutgers.edu/oas/slade>.

### Study Abroad

Many engineering students take advantage of Rutgers' Study Abroad educational opportunities choosing to study for a semester, a summer, or an academic year at one of the many international programs open to Rutgers students. Students can study abroad as early as sophomore year at locations including Hong Kong, Australia, London, South Africa, and more. Orientation sessions provide valuable information for making the necessary educational and logistical plans. For more information, see: <http://soe.rutgers.edu/oas/study-abroad>.

## Cooperative Experience (Co-Op)

Engineering students who have completed required major courses through the first semester of the junior year and have a cumulative GPA of at least 2.5 are eligible to participate in the Co-op program.

The MAE Co-op requires that students complete a 6-month, full-time (40 hrs/wk) work experience in a corporate engineering position, which may earn **6 credits towards technical electives** (see *Note 6*) upon student's request and if the student registers for the Co-op in Mechanical and Aerospace Engineering course (650:496/7). The MAE department requires continuous summer-fall or spring-summer experience.

After a student finds an engineering position in the company of his/her liking the following steps should be accomplished for technical elective credits in MAE:

- Submit job description for approval to the MAE undergraduate office.
- Complete Co-Op MAE form (this form is different from the Career Services one.) <http://mech.rutgers.edu/sites/default/files/Co-Op%20Application.pdf>
- After approval of job description, register for 650:496/497.
- Upon completion of the internship the student should submit at the MAE undergraduate office the following:
  - A technical report of a minimum length of 20 pages, including tables, figures and references.
  - An evaluation letter from his/her supervisor indicating: 1) length and full time employment of the student, 2) his/her duties, and 3) assessment of his performance.

*Note 2:* Since this is a full time job the students are not encouraged to take courses during their co-op experience. If under extenuating circumstances a student is to take a course during his/her Co-Op, the student is reminded that all MAE classes have mandatory attendance and no credit will be given for missed classes.

The Office of Career Services provides listings of co-op opportunities, but students may also obtain positions on their own. For more information, see: <http://soe.rutgers.edu/oas/coop>.

*Note 3:* No credit towards electives in MAE will be given if the student is not registered for 650:496/7.

## Internship Experience

Engineering students who have completed required major courses through the sophomore year and have a cumulative GPA of at least 2.5 are eligible to participate in the Internship program.

The MAE Internship requires that students complete a 3-month, full-time (40 hrs/wk) work experience in a corporate engineering position, which may earn **3 credits towards a technical elective** (see *Note 6*) upon student's request and if the student registers for the Internship in Mechanical and Aerospace Engineering course (650:495). After a student finds an engineering position in the company of his/her liking the following steps should be accomplished to earn technical electives credits in MAE:

- Submit job description for approval to the MAE undergraduate office.
- Complete the MAE Internship form (this form is different from the Career Services one.) <http://mech.rutgers.edu/sites/default/files/Internship%20%20Application.pdf>
- After approval of job description, register for 650:495.
- Upon completion of the internship the student should submit at the MAE undergraduate office the following:
  - A technical report of a minimum length of 20 pages (including tables, figures and references.)
  - An evaluation letter from his/her supervisor indicating: 1) length and full time employment of the student, 2) his/her duties, and 3) assessment of his performance.

*Note 4:* Since this is a full time job the students are not encouraged to take courses during their internship experience. If under extenuating circumstances a student is to take a course during his/her internship, the student is reminded that all MAE classes have mandatory attendance and no credit will be given for missed classes.

The Office of Career Services provides listings of internship opportunities, but students may also obtain positions on their own.

*Note 5:* No credit towards electives in MAE will be given if the student is not registered for 650:495.

## Undergraduate Research

This experience seeks to expand student participation in research projects with mechanical and aerospace engineering faculty. It features high-quality interaction of students with faculty, access to appropriate facilities, and other professional development opportunities.

Students may earn up to **3 credits (total) counting towards a technical elective** upon student's request (see *Note 6*) in MAE if they register under 298, 398, 498 Undergraduate research during the Fall semester and/or 299, 399, 499 Undergraduate research during the Spring semester of their sophomore, junior and senior years, respectively.

The students are required to make a poster presentation of their research project and findings at the end of the academic year if they elect to use their undergraduate research experience for Technical Elective credits.

*Note 6:* **Total number** of Undergraduate Research/Internship/Co-Op experience credits that may count towards a Technical Elective is limited to **6 credits (2 TEs)**.

**Mechanical and Aerospace Engineering  
Rutgers University**

**Prerequisites**

<i>Course Code</i>	<i>Course name</i>	<i>Semester</i>	<i>Option</i>	<i>Prerequisite</i>
<b>160:159</b>	Gen Chem for Engs I			01:640:112 <i>or</i> 01:640:115 <i>or</i> equivalent
<b>160:160</b>	Gen Chem for Engs II			01:640:112 <i>or</i> 01:640:115 <i>or</i> equivalent
<b>160:171</b>	Intro to Experimentation			01:160:159 <i>or</i> 01:160:161 <i>or</i> 01:160:163 <i>AND</i> 01:640:111 <i>or</i> 01:640:115 <i>or</i> equivalent
<b>220:102</b>	Microeconomics			01:640:111 <i>or</i> 01:640:115 <i>or</i> calculus placement
<b>332:373</b>	Elem of Electrical Eng'g	S		01:640:251 <i>AND</i> 01:750:227
<b>332:375</b>	Elem of Electrical Eng'g Lab	S		01:640:251 <i>AND</i> 01:750:227
<b>355:101</b>	Expository Writing			None
<b>440:100</b>	Intro to Eng	S		None
<b>440:127</b>	Intro to Comp for Engs			None
<b>440:221</b>	Engineering: Mechanics: Statics	S		01:640:151 <i>or</i> 01:640:153 <i>or</i> 01:640:191 <i>AND</i> 01:750:115 <i>or</i> 01:750:123 <i>or</i> 01:750:203
<b>440:222</b>	Engineering Mechanics: Dynamics	S		01:640:152 <i>or</i> 01:640:154 <i>or</i> 01:640:192 <i>or</i> 50:640:122 <i>or</i> 21:640:136 <i>AND</i> 14:440:221 <i>or</i> 14:440:291
<b>540:343</b>	Engineering Economics			Open only to junior and senior engineering students
<b>635:407</b>	Mech Properties of Materials			14:440:221 <i>AND</i> 01:160:160 <i>or</i> 01:160:162
<b>640:151</b>	Calculus I for Eng'g			01:640:112 <i>or</i> 01:640:115 <i>or</i> appropriate performance on the placement test in mathematics
<b>640:152</b>	Calculus II for Eng'g			01:640:151
<b>640:251</b>	Multivariable Calculus			01:640:152
<b>640:244</b>	Differential Equations			01:640:251
<b>640:421</b>	Advanced Calculus			01:640:244
<b>750:123</b>	Analytical Physics Ia			Co-req: 01:640:151, 01:640:152
<b>750:124</b>	Analytical Physics Ib			01:750:123
<b>750:227</b>	Analytical Physics IIa			(01:750:123 <i>AND</i> 01:750:124) OR 01:750:271 Co-req: 01:750:229
<b>750:228</b>	Analytical Physics IIb			(01:750:227 <i>or</i> 01:750:204 <i>or</i> 01:750:272) Co-req: 01:750:230
<b>750:229</b>	Analytical Physics IIa Lab			Co-req: 01:750:227
<b>750:230</b>	Analytical Physics IIb Lab			Co-req: 01:750:228
<b>650:210</b>	Intro Aerospace Eng	AF	Core	01:640:152 <i>AND</i> 14:440:221 Co-Req: 01:640:251 <i>AND</i> 14:440:222



<b>650:215</b>	Modern Machining	S	Core	None
<b>650:231</b>	ME Comp Analysis & Design	S	Core	14:440:127
<b>650:291</b>	Mech of Materials	S	Core	14:440:221 <i>or</i> 14:440:291
<b>650:312</b>	Fluid Mechanics	S	Core	14:440:222 <i>or</i> 14:440:292 <i>AND</i> 01:640:244 <i>or</i> 01:640:292 <i>or</i> 50:640:314
<b>650:342</b>	Design Mech Components	S	Core	14:650:231 <i>AND</i> 14:650:291 <i>or</i> 14:180:243 <i>AND</i> 14:440:222 <i>or</i> 14:440:292
<b>650:350</b>	ME Measurements & Lab	S	Core	14:332:373 <i>AND</i> 14:332:375
<b>650:351</b>	Thermodynamics	S	Core	01:640:244 <i>AND</i> (01:750:272 <i>or</i> 01:750:227) <i>AND</i> (01:750:273 <i>or</i> 01:750:228)
<b>650:361</b>	Intro to Mechatronics	ASp	Elective (may replace 332:373/375)	01:640:152 <i>AND</i> 01:640:244 <i>AND</i> 01:750:227
<b>650:388</b>	CAD in Mech Eng'g	S	Core	14:650:215
<b>650:401</b>	Mechanical Control Systems <i>Will be modified to System Dynamics and Controls</i>	AF	Mech	14:440:222 <i>or</i> 14:440:292 <i>AND</i> 01:640:244 <i>or</i> 01:640:292 <i>or</i> 50:640:314
<b>650:431</b>	ME Lab I	AF	Core	(14:650:312) <i>AND</i> (14:650:342) <i>AND</i> (14:650:349) <i>AND</i> (14:650:350) <i>AND</i> (14:650:351)
<b>650:432</b>	MAE LAB II (ME option)	ASp	Mech	(14:650:312) <i>AND</i> (14:650:342) <i>AND</i> (14:650:349) <i>AND</i> (14:650:350) <i>AND</i> (14:650:351)
<b>650:433</b>	MAE LAB II (AE option)	ASp	Aero	(14:650:312) <i>AND</i> (14:650:349) <i>AND</i> (14:650:350) <i>AND</i> (14:650:351)
<b>650:435</b>	MAE LAB II (Energy option)	ASp	Energy	(14:650:312) <i>AND</i> (14:650:342) <i>AND</i> (14:650:349) <i>AND</i> (14:650:350) <i>AND</i> (14:650:351)
<b>650:439</b>	Multiphysics Simulations	AF	Core	14:650:312 <i>AND</i> 14:650:342 <i>AND</i> 14:650:351
<b>650:443</b>	Vibrations	S	Core	(14:440:222 <i>AND</i> 01:640:421 <i>AND</i> 14:650:291) <i>OR</i> (14:440:292 <i>AND</i> 01:640:421 <i>AND</i> 14:650:291)
<b>650:447</b>	Probabilistic models in MAE	BF(E)	Aero/Mech	01:640:421
<b>650:449</b>	Intro to Mech of Comp Mate <i>Will be modified to Aerospace Materials</i>	AF	Aero/Mech	14:650:291
<b>650:451</b>	Vehicle Dynamics	BF(O )	Mech	14:440:222 <i>or</i> 14:440:292
<b>650:455</b>	Design of Mechanisms	AF	Mech	14:440:222 <i>or</i> 14:440:292
<b>650:457</b>	Spacecraft & Mission Des	AF	Core	14:650:342 <i>AND</i> 14:650:388
<b>650:458</b>	Aerospace Structures	ASp	Aero/Mech	14:650:291
<b>650:459</b>	Aerospace Propulsion	BS(E)	Aero/Mech	14:540:312 <i>AND</i> 14:650:351
<b>650:460</b>	Aerodynamics	AF	Aero/Mech	14:650:312 <i>AND</i> 14:650:351
<b>650:461</b>	Internal Combustion Engines	ASp	Energy/Mech	14:650:351
<b>650:462</b>	Power Plants	AF	Energy/Mech	14:650:351
<b>650:463</b>	Compressible Fluid Mechanics	BS(O )	Aero/Mech	14:650:312

<b>650:465</b>	Orbital Mechanics	ASp	Aero/Mech	14:650:312 <i>AND</i> 14:650:351
<b>650:467</b>	Design & Manufacturing I	AF	Core	14:650:231 <i>AND</i> 14:650:342 <i>AND</i> 14:650:388
<b>650:468</b>	Design & Manufacturing II	ASp	Core	14:650:467
<b>650:471</b>	Aircraft Flight Dynamics	AF	Aero/Mech	((14:440:221 <i>or</i> 14:440:291 <i>or</i> 14:440:291) <i>AND</i> (01:640:421)) OR ((14:440:222 <i>or</i> 14:440:292 <i>or</i> 14:440:292) <i>AND</i> (01:640:421))
<b>650:474</b>	Alternative Energy I	AF	Energy/Mech	14:650:351
<b>650:477</b>	Alternative Energy II	ASp	Energy/Mech	14:650:351
<b>659:478</b>	ME Aspects to Electronic Packaging	ASp	Mech	14:650:342 <i>AND</i> 14:650:351
<b>650:481</b>	Heat Transfer	S	Core	01:640:421 <i>AND</i> 14:650:312 <i>AND</i> 14:650:351
<b>650:485</b>	Computing Environment	ASp	Elective	14:650:231 <i>AND</i> 14:650:342
<b>650:487</b>	Aerospace Design Proj. I	AF	Core	14:650:342 <i>AND</i> 14:650:388
<b>650:488</b>	Aerospace Design Proj. II	ASp	Core	14:650:487
<b>Undergrad Research/Internship/Co-Op/ JJ Slade Courses</b>				
<b>650:298</b>	UG Research for Soph	AF	Elective	
<b>650:299</b>	UG Research for Soph	ASp	Elective	
<b>650:398</b>	UG Research for Jrs	AF	Elective	
<b>650:399</b>	UG Research for Jrs	ASp	Elective	
<b>650:498</b>	UG Research for Srs	AF	Elective	
<b>650:499</b>	UG Research for Srs	ASp	Elective	
<b>650:495</b>	Internship in MAE	S	Elective	2.5 GPA & approval of job description
<b>650:496</b>	Co-Op in MAE	AF	Elective	2.5 GPA & approval of job description
<b>650:497</b>	Co-Op in MAE	ASp	Elective	2.5 GPA & approval of job description
<b>650:542</b>	JJ Slade Research	AF	Elective	3.2 GPA
<b>650:543</b>	JJ Slade Research	ASp	Elective	3.2 GPA

#### Legend

S	Semester	BF(O)	Biannual Fall (Odd Years)
AF	Annual Fall	BS(E)	Biannual Spring (Even Years)
ASp	Annual Spring	BS(O)	Biannual Spring (Odd Years)
BF(E)	Biannual Fall (Even Years)		

**Students should reference the following link for complete and detailed list of MAE courses and their prerequisites:**

[http://catalogs.rutgers.edu/generated/nb-ug\\_current/pg1267.html](http://catalogs.rutgers.edu/generated/nb-ug_current/pg1267.html)

## SAS Course Descriptions

### CHEMISTRY

01:160:159-160

Introduction to chemical principles and their application. Includes stoichiometry, states of matter, atomic and molecular structure, solutions, thermodynamics, equilibrium, oxidation-reduction, kinetics, nonmetals, metals and coordination compounds, and nuclear chemistry. Lec. 2 hrs., rec. 1 hr. Prerequisite or corequisite for 159: 01:640:112 or 115 or equivalent. Prerequisite for 160: 01:640:112 or 115 or equivalent. Pre- or corequisite for 160: 01:160:171. Credit not given for both these courses and 01:160:161-162 or 163-164.

01:160:171

Laboratory illustrating basic chemical methods. Lab fee required. Lab. 3 hrs. Pre- or corequisite: 01:160:159, 161, or 163. Prerequisite: 01:640:111 or 115 or equivalent.

### MATHEMATICS

01:640:151-152

Calculus for Mathematical and Physical Sciences (4,4) Math 151: Same topics as 01:640:135, with additional theory and numerical applications. Math 152: Techniques of integration, elementary differential equations, sequences, infinite series, Taylor series, parametric equations, polar coordinates. For mathematics, physics, computer science, statistics, chemistry, or engineering majors. Prerequisite for 151: 01:640:112 or 115 or appropriate performance on the placement test in mathematics. Prerequisite for 152: CALC1. Credit restrictions: CR1, CR2.

01:640:251

Multivariable Calculus (4) Analytic geometry of three dimensions, partial derivatives, optimization techniques, multiple integrals, vectors in Euclidean space, and vector analysis. Prerequisite: CALC2. Credit restriction: CR3.

01:640:244

Differential Equations for Engineering and Physics (4) First- and second-order ordinary differential equations; introduction to linear algebra and systems of ordinary differential equations. Prerequisite: CALC3. Credit restriction: CR4.

01:640:421

Advanced Calculus for Engineering (3) Laplace transforms, numerical solution of ordinary differential equations, Fourier series, and separation of variables method applied to the linear partial differential equations of mathematical physics (heat, wave, and Laplace's equation). Primarily for mechanical engineering majors. Prerequisite: CALC4. Credit not given for both this course and 01:640:423.

### PHYSICS

01:750:123-124

Analytical Physics I (2,2) Forms a thorough introductory sequence together with 01:750:227, 228. Kinematics, dynamics, energy, momentum, angular momentum, heat, and kinetic theory. Lec. 1 hr., rec. 1 hr. Corequisites: 01:640:151-152. Primarily for engineering and physics majors. This course should be followed by 01:750:227, 228 (or 204 if changing major).

01:750:227

Analytical Physics IIA (3) Electrostatics, particles in electric and magnetic fields, electromagnetism, circuits, Maxwell's equations, electromagnetic radiation. Prerequisites: 01:750:123-124 or 271. Corequisite: 01:750:229. Primarily for engineering and physics majors.

01:750:228

Analytical Physics IIB (3) Waves and optics, relativity, quantum properties of electrons and photons, wave mechanics, atomic, solid state, nuclear, and elementary particle physics. Prerequisite: 01:750:227 or 204 or 272. Corequisite: 01:750:230. Primarily for engineering and physics majors.

01:750:229-230

Analytical Physics II Laboratory (1,1) Laboratory to complement 01:750:227 and 228. Corequisites: 01:750:227 and 228.

## **SOE First/Second Year Course Descriptions**

14:440:221

Engineering Mechanics: Statics (3) Classification of systems of forces and their resultants; geometrical and analytical conditions for the equilibrium of force systems; frames and trusses; friction; parabolic and catenary cables; centers of gravity. Prerequisites: 01:640:151 or 153 or 191; and 01:750:115 or 123 or 203.

14:440:222

Engineering Mechanics: Dynamics (3) Kinematics of particles and rigid bodies; rectangular, path, and polar descriptions. Relative motion. Kinetics of particles, particle systems, and rigid bodies; equations of motion, principles of work and energy, linear and angular impulse and momentum. Impact. Prerequisites: 01:640:152 or 154 or 192 or 50:640:122 or 21:640:136; and 14:440:221 or 291; and 01:750:124 (or equivalent).

14:440:291

Honors Engineering Mechanics: Statics (3) Covers the same material as 14:440:221 but in a more thorough and demanding fashion. Open only to honors program participants.

14:440:292

Honors Engineering Mechanics: Dynamics (3) Covers the same material as 14:440:222 but in a more thorough and demanding fashion. Open only to honors program participants.