

# COLLEGE OF ENGINEERING

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[www.engineering.iastate.edu](http://www.engineering.iastate.edu) (<http://www.engineering.iastate.edu/>)

## Aligning Education in Engineering with the University Mission

The mission of Iowa State University is to create, share, and apply knowledge to make Iowa and the world a better place. Students will become broadly educated, global citizens who are culturally informed, technologically adept, and ready to lead. The College of Engineering echoes this philosophy and emphasizes preparing its graduates to meet the challenges of the 21st century.

Engineering education seeks to develop a capacity for objective analysis, synthesis, and design to obtain a practical solution. The engineering programs at Iowa State University are designed to develop the professional competence of a diverse student body and, by breadth of study, to prepare students to solve the technical problems of society while considering the ethical, social, and economic implications of their work at state, national and global levels.

The focus of each curriculum is to strengthen students' critical thinking, creative abilities, and communication skills. Students in engineering will have the opportunity for interdisciplinary and experiential learning through learning communities, service learning, internships and cooperative education, as well as research, capstone, and study abroad experiences.

The problem-solving skills learned from an engineering education at Iowa State University also provide an excellent launching pad for careers not only in engineering, but also medicine, law, business, and many other fields.

Registration as a professional engineer, which is granted by each individual state, is required for many types of positions. The professional curricula in engineering at Iowa State University are designed to prepare a graduate for subsequent registration in all states.

Seniors in accredited curricula of the College of Engineering are encouraged to take the Fundamentals of Engineering Examination toward professional registration during their final academic year. Seniors in engineering curricula who have obtained at least 6 semester credits in surveying may take the Fundamentals Examination for professional registration as land surveyors.

## Concurrent Graduate/ Undergraduate Programs

Several engineering programs offer the opportunity for well-qualified undergraduate juniors and seniors to pursue a graduate degree in their program while finishing the undergraduate requirements. The programs offering concurrent undergraduate/graduate degrees are: aerospace engineering, agricultural engineering, biological systems engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, industrial engineering, materials engineering, mechanical engineering and software engineering.

Programs offering concurrent bachelor of science/master of business administration degrees are: aerospace engineering, agricultural engineering, biological systems engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, industrial engineering, materials engineering, mechanical engineering and software engineering. For more information, refer to the graduate study sections for each engineering program. Advanced work in engineering is offered in the post-graduate programs. See the Graduate College (<http://catalog.iastate.edu/previouscatalogs/2020-2021/graduatecollege/>) section of this catalog.

## Joint Undergraduate Programs

A bachelor of science degree in software engineering is offered in the College of Engineering and the College of Liberal Arts and Sciences.

## Accreditation

Twelve undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org> (<http://www.abet.org/>). These twelve programs are: aerospace, agricultural, biological systems, chemical, civil, computer, construction, electrical, industrial, materials, mechanical and software engineering. Accreditation status is indicated in the Courses and Programs section for each engineering program.

## Organization of Curricula

All curricula in engineering are designed as four-year programs. They are structured in two phases: a basic program and a professional program. The basic program consists primarily of subjects fundamental and common to all branches of engineering and includes chemistry, physics, mathematics, engineering computations, and English. The professional phase of a curriculum includes intensive study in a particular branch of engineering, as well as a continuation of supporting work in mathematics, basic sciences, humanities, and social sciences.

Students should complete the requirements of the basic program before proceeding to a professional program.

## Preparation for the Engineering Curricula

In addition to the standard university admission requirements, the college also requires 2 years of a foreign language. Other high school credits particularly important to students wishing to study engineering include:

- 2 years of algebra,
- 1 year of geometry
- 1/2 year of trigonometry
- 1/2 year of pre-calculus
- 1 year each of chemistry, biology, and physics
- 3 years of social science
- 4 years of English

See Index (<http://catalog.iastate.edu/previouscatalogs/2020-2021/azindex/>) for specific admission requirements.

Placement in mathematics, English, and chemistry will generally be based on high school preparation and test scores. Advanced placement is possible for exceptionally well-prepared students. Students who are not adequately prepared may be encouraged or required to take additional preparatory coursework and should expect to spend more than the customary time to complete the engineering program. Any coursework which is preparatory or remedial in nature cannot be used to satisfy credit requirements for graduation in any of the engineering curricula.

## Engineering Basic Program

Please see "Basic Program for Engineering Curricula" section.

## Requirement for Graduation

In order to graduate in a professional engineering curriculum, students must have a minimum GPA of 2.00 in a department-designated group of 200-level and above courses known as the Core. These courses will total no fewer than 24 semester credits.

## Engineering Minors

The College of Engineering offers four undergraduate minors which are open only to students in the College of Engineering. These are minors in biomedical engineering, energy systems, engineering sales and nondestructive evaluation. These minors must include at least nine credits which are beyond the total used to meet curriculum requirements.

The biomedical engineering minor is a 17 credit interdisciplinary program that complements a student's major discipline by providing additional insight into the interactions between various engineering disciplines and Biological systems. The minor is administered by a supervisory faculty committee. For minor course requirements, refer to Biomedical Engineering in Courses and Programs.

The energy systems minor is a 15 credit program that provides engineering students with focused educational opportunities in the broad area of energy systems. Students will understand broad energy perspectives, the language of energy systems and the economic, environmental, and policy issues related to energy. The minor is administered by a supervisory faculty committee. For minor course requirements, refer to Energy Systems in Courses and Programs or see <http://www.me.iastate.edu/energy-systems-minor/>.

The engineering sales minor is a 15 credit minor that complements the technical training in the student's major discipline by providing the tools and knowledge required for technical (i.e. business-to-business) sales careers. The minor is administered by a supervisory faculty committee. For minor course requirements, refer to Engineering Sales in Courses and Programs.

The nondestructive evaluation minor (16 credit minimum) open to engineering students who have met the basic program requirements and are not on academic warning or probation. The minor is supervised by an inter-disciplinary Engineering faculty committee. For minor course requirements, refer to Nondestructive Evaluation Engineering in Courses and Programs.

## Engineering Minor (Interdisciplinary)

The College of Engineering offers undergraduate minors in wind energy and cyber security which are open to all students at ISU who meet the prerequisites. The wind energy minor is a 15 credit minor which enables students to acquire an interdisciplinary knowledge of the wind energy industry. There are two required courses; the remaining credits are chosen from a list of elective courses that are related to wind energy. The minor is administered by a supervisory faculty committee from several departments. For minor course requirements, refer to Wind Energy Minor in Courses and Programs. The cyber security minor is a 15 credit minor that is intended for students studying computer engineering, computer science, software engineering or management information systems with the goal of enabling them to work in cyber security. For minor course requirements, refer to the Cyber Security in Courses and Programs.

## Undergraduate Majors and Minors Outside the College of Engineering

In addition to the engineering degree program, students may earn majors or minors in other colleges of the university. A major or minor program must meet all requirements of the offering department or program and its college and contain credits beyond the requirements for a B.S. degree in engineering. A minimum of 15 additional credits is required for each major area of study and an additional 9 credits for each minor.

## Advising System

The purpose of the advising system in the College of Engineering is to work constructively with students in developing their individual academic programs and to provide a resource contact person for students during their college careers.

The college offers an orientation program during the spring and summer for students planning to enter in the fall, and during the fall for students planning to enter in the spring. Transfer students may also complete orientation online. All entering students are encouraged to attend orientation which includes meeting with an academic adviser to register for classes. Placement assessments given during the orientation program help determine the student's current level of proficiency which enables the academic adviser to prepare an appropriate course schedule for the student.

## Special Programs

All engineering students are strongly encouraged to participate in either the cooperative education or internship programs. Students who are qualified to participate in the engineering honors program are also urged to do so. These programs are integrated into the professional engineering curricula and may require additional work. However, both these professional and academic programs offer opportunities that will enrich the standard academic experience. Engineering students are also encouraged to take advantage of study abroad opportunities available through the College of Engineering's International Programs Office.

a. Cooperative Education Program. The College of Engineering offers, through its curricula, an experiential education program. Enrollment in the program allows students to gain practical work experience in their career field while attending college. In general, students enrolled in the co-op program will require an additional semester to complete curriculum requirements.

Cooperative programs are a mechanism by which a student may work full-time for one semester per academic or calendar year. The student has the opportunity to assess career paths within her/his chosen curriculum and the employer evaluates the student's potential as a future full-time employee. Both domestic and international co-op programs are allowed. Cooperative education students pay no tuition to the university during their work periods and do not receive credit hours for their work experience. Students register for a non-credit cooperative education course (398) for fall or spring and are considered full-time students while enrolled in these courses. For additional information contact your academic adviser and the Office of Engineering Career Services.

b. Internship Program. The College of Engineering offers, through its curricula, an experiential education program. Internships are a mechanism by which a student may work full-time for the summer.

Enrollment in the program allows students to gain practical work experience in their career field while attending college. Internship students pay no tuition to the university during their work periods and do not receive credit hours for their work experience. Students who register for the internship course (396) for the summer are considered to be full-time students. For additional information contact your academic adviser and the Office of Engineering Career Services.

c. Honors Program. The College of Engineering participates in the University Honors Program (see Index (<http://catalog.iastate.edu/previouscatalogs/2020-2021/azindex/>)). The honors program is designed for students with above average ability who wish to individualize their programs of study. For further details consult the chair of the Engineering College Honors Program Committee or your departmental honors program adviser.

d. Engineering International Engagement. In a world where the sun never sets, engineers must be prepared to understand other cultures and other ways of doing business. Engineers must expand their exportable skills, language and cross-cultural skills.

The College of Engineering has formed worldwide partnerships to create opportunities for students to work and study with leading universities in other countries and multinational corporations. With careful planning, students may earn credit in courses that fulfill their degree requirements. To learn more about work and study abroad, visit the Engineering International Engagement website: <http://www.engineering.iastate.edu/studyabroad/>

## Departments of the College

For information on undergraduate options refer to the following curriculum sections, and for graduate specializations or certificate programs, refer to the Courses and Programs section of the catalog.

- Aerospace Engineering
- Agricultural and Biosystems Engineering
- Chemical and Biological Engineering
- Civil, Construction and Environmental Engineering
- Electrical and Computer Engineering
- Industrial and Manufacturing Systems Engineering
- Materials Science and Engineering
- Mechanical Engineering

## Degree Programs

Aerospace Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/aerospaceengineering/>)

Agricultural Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/agriculturalengineering/>)

Biological Systems Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/biologicalsystemsengineering/>)

Chemical Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/chemicalengineering/>)

Civil Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/civilengineering/>)

Computer Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/computerengineering/>)

Construction Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/constructionengineering/>)

Cyber Security Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/cybersecurityengineering/>)

Electrical Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/electricalengineering/>)

Engineering Mechanics (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/engineeringmechanics/>)

Industrial Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/industrialengineering/>)

Information Assurance (<http://catalog.iastate.edu/previouscatalogs/2020-2021/interdisciplinaryprograms/graduate/informationassurance/>)

Materials Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/materialsengineering/>)

Materials Science and Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/materialsscienceandengineering/>)

Mechanical Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/mechanicalengineering/>)

Software Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/softwareengineering/>)

Systems Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/systemsengineering/>)

## Minors

Biomedical Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/biomedicalengineering/>)

Cyber Security (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/cybersecurityminor/>)

Energy Systems (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/energy-systems-minor/>)

Engineering Sales (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/engineeringsales/>)

Non-Destructive Evaluation Engineering ([http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/non\\_destructiveevaluationengineering/](http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/non_destructiveevaluationengineering/))

Wind Energy (<http://catalog.iastate.edu/previouscatalogs/2020-2021/interdisciplinaryprograms/minor/windenergy/>)

## Engineering

Engineering (<http://catalog.iastate.edu/previouscatalogs/2020-2021/collegeofengineering/>)

## Two Bachelor's Degrees versus a Degree and Second Major

A student with multiple curricula within the College of Engineering is permitted to earn only multiple degrees. All requirements for each curricula must be met plus an additional 30 credits for each curricula being pursued beyond the curriculum which requires the most credits.

Students in the College of Engineering are able to earn a degree with a second major/curriculum as long as the second major/curriculum is within another college, meets all requirements of the additional programs and contains a minimum of 15 additional credits beyond the requirements for a B.S. degree in engineering for each additional area of study.

## Basic Program for Engineering Curricula

The Basic Program is a set of courses that provides a foundation common to all engineering curricula. Students normally enroll in most of the Basic Program courses during their first year. Before enrolling in engineering courses at the 200-level and above, students enrolled in the College of Engineering must do the following:

1. Complete the Basic Program with a Basic Program grade point average (GPA) of at least 2.00.
2. Earn an ISU cumulative GPA of at least 2.00.

A grade of C or better is required for any transfer credit course applied to the Basic Program. Grades from transfer courses will not be used in computing the Basic Program GPA.

Students enrolled in the College of Engineering who have not met the above requirements may enroll for no more than two semesters in 200-level engineering courses. Students not enrolled in the College of Engineering may take engineering courses as long as they meet the prerequisites and space is available; only the first two semesters of engineering courses at the 200-level and above taken at ISU while a student is not enrolled in the College of Engineering can be applied toward an engineering degree.

Entering undergraduates must demonstrate proficiency in trigonometry based on test scores, or by having transfer credits from a college trigonometry course, or by passing MATH 143 Preparation for Calculus before enrolling in MATH 165 Calculus I.

The Department of English may recommend placement in one or more sections of ENGL 099 (<http://catalog.iastate.edu/previouscatalogs/2020-2021/azcourses/engl/>) or ENGL 101 English for Native Speakers of Other Languages if the placement test administered to students whose first language is not English indicates deficiencies. Satisfactory completion of the recommended English course(s) will be required of students to complete their Basic Program.

### Basic Program

**(A minimum GPA of 2.00 required for this set of courses. Transfer courses are not used in the Basic Program GPA computation).**

MATH 165	Calculus I	4
MATH 166	Calculus II	4
ENGL 150	Critical Thinking and Communication (Must have a C or better)	3
CHEM 167 or CHEM 177 or CHEM 201	General Chemistry for Engineering Students General Chemistry I Advanced General Chemistry	4-5
PHYS 221	Introduction to Classical Physics I	5
ENGR 101	Engineering Orientation *	R
LIB 160	Information Literacy	1
ENGR 160	Engineering Problems with Computer Applications Laboratory	3

Or one of the following in place of ENGR 160

AER E 160	Aerospace Engineering Problems With Computer Applications Laboratory	
A B E 160	Systematic Problem Solving and Computer Programming	
C E 160	Engineering Problems with Computational Laboratory	
CH E 160	Chemical Engineering Problems with Computer Applications Laboratory	
CPR E 185	Introduction to Computer Engineering and Problem Solving I	

E E 185	Introduction to Electrical Engineering and Problem-Solving I	
I E 148	Information Engineering	
M E 160	Mechanical Engineering Problem Solving with Computer Applications	
S E 185	Problem Solving in Software Engineering	
<b>Total Credits</b>		<b>24-25</b>

ENGL 250 Written, Oral, Visual, and Electronic Composition is normally taken in the second year. Credit for ENGL 150 Critical Thinking and Communication is earned upon successful completion of ENGL 250 Written, Oral, Visual, and Electronic Composition, but only when ENGL 250 Written, Oral, Visual, and Electronic Composition is completed at Iowa State.

\* Students enrolled in the joint software engineering degree program should take S E 101 Software Engineering Orientation, note that ENGR 101 can be substituted for S E 101.

### Engineering Courses (ENGR)

Most of the courses with the designator of Engr are broad-based engineering courses applicable to all engineering disciplines. Several of these courses are part of the basic program which is required for engineering students. All courses are administered by the college and with the exception of ENGR 160 (<http://catalog.iastate.edu/previouscatalogs/2020-2021/search/?P=ENGR%20160>) Engineering Problems with Computer Applications Laboratory, ENGR 340 (<http://catalog.iastate.edu/previouscatalogs/2020-2021/search/?P=ENGR%20340>) Introduction to Wind Energy: System Design & Delivery, ENGR 466 (<http://catalog.iastate.edu/previouscatalogs/2020-2021/search/?P=ENGR%20466>) Multidisciplinary Engineering Design and ENGR 467 (<http://catalog.iastate.edu/previouscatalogs/2020-2021/search/?P=ENGR%20467>) Multidisciplinary Engineering Design II Multidisciplinary Engineering Design II are coordinated through Engineering Student Services in Engineering Academic and Student Affairs.

ENGR 160	Engineering Problems with Computer Applications Laboratory	3
ENGR 340	Introduction to Wind Energy: System Design & Delivery	3
ENGR 466	Multidisciplinary Engineering Design	3
ENGR 467	Multidisciplinary Engineering Design II	3

**Courses primarily for undergraduates:**

**ENGR 101: Engineering Orientation**

Cr. R. F.S.

Introduction to the College of Engineering and the engineering profession. Information concerning university and college policies, procedures, and resources. Undeclared sections: Considerations in choosing an engineering curriculum. Opportunities to interact with departments. Declared sections: Introduction to major-specific topics. Offered on a satisfactory-fail basis only.

**ENGR 104: LEAD Program Orientation**

(1-0) Cr. 1. F.

Orientation for LEAD Learning/Living Community participants. Introduction to college and university resources, tools and techniques to promote academic, professional and social/cultural development and success. Focus on building support networks with peers, faculty, and staff. Introduction to core engineering competencies including but not limited to initiative, communication, teamwork, and cultural adaptability. Offered on a satisfactory-fail basis only.

**ENGR 105: LEAD Program Seminar**

(1-0) Cr. 1. S.

Seminar for LEAD Learning/Living Community participants. Focus on professional development and exposure to various engineering disciplines through hands-on lab experiences, industry visits and networking opportunities with alumni, faculty, and staff. Development of core competencies: engineering/technical knowledge, communication and teamwork. Offered on a satisfactory-fail basis only.

**ENGR 131: Learning Community Seminar**

Cr. R. F.

Peer-mentored review of course topics in engineering undeclared learning communities. Offered on a satisfactory-fail basis only.

**ENGR 150: Foundations of Leadership Development and Learning**

(1-0) Cr. 1. F.S.

*Prereq: ELP students only*

Leadership development with focus on global context and awareness of events shaping the context. Exposure to theory of leadership with examples. Necessary characteristics of a leader, and strategies for leadership skills development. Exposure to non-traditional career paths for engineers. Outline of personalized leadership development. Offered on a satisfactory-fail basis only.

**ENGR 160: Engineering Problems with Computer Applications Laboratory**

(2-2) Cr. 3. F.S.SS.

*Prereq: MATH 143 or satisfactory scores on mathematics placement examinations*

Solving engineering problems and presenting solutions through technical reports. Significant figures. Use of SI units. Graphing and curve-fitting. Flowcharting. Introduction to mechanics, statistics and engineering economics. Use of spreadsheet programs to solve and present engineering problems. Solution of engineering problems using computer programming languages. (The honors section includes application of programming to mobile robotics).

**ENGR 250: Leadership in Engineering Teams**

(1-0) Cr. 1. F.S.

Building and sustaining decision-making engineering teams. Students will explore the interrelated processes of discerning purpose, thinking systemically, developing reflective judgment, and exercising leadership by mobilizing and setting the direction for adaptive change within a team. Industry based examples and information from engineering and natural resource sciences will be infused into the course.

**ENGR 260: Engineering: Getting from Thought to Thing**

(Cross-listed with IND D). (3-0) Cr. 3. F.S.

What is engineering, technology and their roles in society? Investigation of engineering methods through case studies of everyday objects. Explore questions about the impact of technology in society. Apply engineering methods to design and failure analysis.

**ENGR 265: Survey of the Impacts of Engineering Activity**

(3-0) Cr. 3. F.S.

Survey of the economic, environmental, societal, and political benefits and problems resulting from engineering activity. Effects of engineering projects on human health, social structures, and the environment. Examination of improvements in economic opportunities and quality of life resulting from engineering activity. Case studies of the effects of engineering activity.

**ENGR 270: Survey of How Things Work**

(Cross-listed with IND D). (3-0) Cr. 3. F.S.

Removing mysteries surrounding science and technology. Identify key concepts from applied science and technology to obtain better understanding on how things work. Review and explain the principles behind the technologies which define our modern way of life. A survey of broad range of technology could include: cell phones, GPS, radio, television, computers, ultrasound, microwave ovens, automobile, bioengineering and other industrial and consumer technologies. Common day technology examples illustrating scientific knowledge and applications.

**ENGR 320: International Experience Report**

Cr. 3. F.S.

*Prereq: Satisfactory completion of international work experience of at least ten weeks or nine credits of approved course work taken abroad. Permission of student's department prior to departure*

Critique of work/study abroad experience as it relates to professional development. Taken the semester after completion of work abroad or study abroad. Written report and presentation. Offered on a satisfactory-fail basis only.

Meets International Perspectives Requirement.

**ENGR 327: Voices of Public Policy**

(3-0) Cr. 3. F.

*Prereq: Sophomore classification in engineering*

Role and impact of legislative process, partisan politics, government, lobbyists, the media, expert testimony and grassroots activism on public policy. Critical analysis of context; of claims, assumptions, premises, and evidence of both sides; represented and disenfranchised populations; the ethical issues to develop personal position and courses of action to impact public policy process.

**ENGR 340: Introduction to Wind Energy: System Design & Delivery**

(3-0) Cr. 3. F.

*Prereq: MATH 166, PHYS 222*

Introduction to wind energy. Economic analysis related to wind energy. Electrical power generation, transmission, and grid operations. Tower, blade and nacelle materials and manufacturing. Tower design. Construction, transportation, supply chain and life cycle analysis for wind turbine components.

**ENGR 350: Dean's Leadership Seminar**

(1-0) Cr. 1. F.S.

*Prereq: Selection based on demonstrated commitment to leadership development; for junior status or above.*

Understanding the complexities of leadership in building an organization, decision-making styles, communication, managing change, building trust, shared responsibility leadership, creating legacy, prioritizing, effective use of authority, conflict, ethics, integrity, transparency, accountability. Offered on a satisfactory-fail basis only. May not apply toward a degree in Engineering

**ENGR 430: Entrepreneurial Product Engineering**

(Cross-listed with I E). Cr. 3. F.Alt. S., offered irregularly.

*Prereq: Junior Classification*

Process of innovative product development in both entrepreneurial and intra-preneurial settings. Define, prototype and validate a product concept based on competitive bench-marking, market positioning and customer requirement evaluation in a target market into a product design that is consistent with defined business goals and strategies. Combination of lecture, discussion, problem solving and case study review.

**ENGR 466: Multidisciplinary Engineering Design**

(Cross-listed with A B E, AER E, B M E, CPR E, E E, I E, M E, MAT E). (1-4)

Cr. 3. Repeatable. F.S.

*Prereq: Student must be within two semesters of graduation; permission of instructor.*

Application of team design concepts to projects of a multidisciplinary nature. Concurrent treatment of design, manufacturing, and life cycle considerations. Application of design tools such as CAD, CAM, and FEM. Design methodologies, project scheduling, cost estimating, quality control, manufacturing processes. Development of a prototype and appropriate documentation in the form of written reports, oral presentations and computer models and engineering drawings.

**ENGR 467: Multidisciplinary Engineering Design II**

(Cross-listed with AER E, I E, M E, MAT E). (1-4) Cr. 3. Repeatable, maximum of 2 times. Alt. F., offered irregularly. Alt. S., offered irregularly.

*Prereq: Student must be within two semesters of graduation or receive permission of instructor.*

Build and test of a conceptual design. Detail design, manufacturability, test criteria and procedures. Application of design tools such as CAD and CAM and manufacturing techniques such as rapid prototyping. Development and testing of a full-scale prototype with appropriate documentation in the form of design journals, written reports, oral presentations and computer models and engineering drawings.

**ENGR 490E: Entrepreneurship**

Cr. 1-3. Repeatable, maximum of 3 credits.

*Prereq: Junior or senior classification in engineering, college approval*

**ENGR 490L: Independent Study**

Cr. 1-3. Repeatable, maximum of 3 credits. F.S.SS.

Leadership.