



University Bulletin

Undergraduate Degree Programs

Engineering

The COLLEGE OF ENGINEERING is committed to educate students so that they may acquire theoretical knowledge and technical competence in the design, development, and creation of components, systems, and processes to address the needs and problems of our society. The college offers an integrated and professionally oriented curriculum focused on developing engineering graduates who are solidly grounded and technically broad in perspective and capabilities, effective in group operations and communication, innovative, and aware of the world.

Resident education at the baccalaureate level is provided through thirteen majors available at University Park and two majors offered at Penn State campuses. In addition, a number of associate degree programs are offered at campus college locations. All baccalaureate degree programs are of eight semesters' duration except Architectural Engineering, which requires ten semesters to complete. Each degree program provides basic elements of general education consistent with the objectives of the program and institution as well as a professional component to prepare graduates for practice in the discipline. All baccalaureate engineering majors at University Park, with the exception of Bioengineering, Biological Engineering, and Computer Science, are accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; o www.abet.org (<http://www.abet.org>).

In each of the engineering disciplines, as designated by the majors, students acquire knowledge of mathematics and the sciences basic to engineering and computer science, and the ability to solve problems through experimentation and analysis. Students develop and exercise initiative, judgment, and creativity through the professional component and design experiences that are integrated across their baccalaureate study, culminating in a capstone design experience in the senior year. Emphasis is placed on application of the engineering method, the capability for critical thinking, teamwork, and the ability to communicate clearly, both orally and through written composition. The social-humanistic component of the curriculum extends throughout the baccalaureate study in all majors and provides students with knowledge of social and human relationships as well as an appreciation of cultural interests and contemporary issues. It includes elective courses in the arts, humanities, and social and behavioral sciences. Through these courses and their study in the majors, students learn to appreciate values and costs, the context of engineering in society, and the ethical characteristics of engineering practice.

With this knowledge and set of skills, graduates are positioned to enter technical and non-technical careers in the industrial, government and private sectors, and/or to pursue advanced study in a variety of disciplines. Their versatility and ability to learn independently enables graduates to acquire new skills and knowledge as required by their career choices. The college also administers several academic minors that permit students to broaden or supplement their technical training; obtain specialized training in leadership, entrepreneurship or product development; or expand their knowledge of the interrelationship of science and society. The Learning Factory, Center for Engineering Design and Entrepreneurship, and Student Activities Center collectively serve the needs of students by providing facilities for project work, computing, and organizational meetings.

The college provides, in addition to undergraduate education, programs in cooperative education, international study and internships, continuing education, research, and advanced study at the graduate level.

For additional information refer to:

<http://www.engr.psu.edu/Departments/> (<http://www.engr.psu.edu/Departments/>)

ENGINEERING COOPERATIVE EDUCATION PROGRAM -- Housed within the Engineering Career Resources office, the Engineering Co-op & Internship Program provides opportunities for students to obtain up to one full year of career-related experience while earning their degree. Students apply theories learned in the classroom to business, government, or industry settings while gaining valuable professional experience, confirming their choice of major, developing technical skills, enhancing communication and job search skills, and receiving compensation that can be used to offset the cost of their education. The program is

available to engineering students at all Penn State campus locations. Participants also have access to the Professional Development Program, which arranges professional skills workshops for students on a variety of topics generated from student and employer evaluation feedback.

Students may choose to complete either a co-op or an internship. Co-op experiences are divided into three segments made up of various combinations of fall, spring, and summer sessions (excluding a three-summer option). These work assignments alternate with academic periods in school but are intentionally flexible in order to accommodate different academic course scheduling requirements. All co-op work experiences are paid and career-related, and students have increasing levels of responsibility over the course of multiple assignments with one or more employers. The internship option provides an opportunity for students to gain one semester—or more, if desired—of career-related experience. The work experience can be pursued during any semester, although the summer semester is the most common choice, and can begin as early as the second semester of students' first year at Penn State.

For additional information, please go to:

<http://www.engr.psu.edu/coop> (<http://www.engr.psu.edu/coop>)

INTERNATIONAL ENGINEERING PROGRAMS -- Through its study and work abroad programs and opportunities, the College provides students with a way to develop a global perspective, learn how engineering is practiced in other countries, make international contacts, and improve their potential for career advancement. Students in the college can earn Penn State credits and/or transfer credits for courses completed abroad. The University currently has agreements with numerous institutions in all parts of the world for study exchange programs. In a program offered by the College of the Liberal Arts, qualified students can pursue both an engineering degree and a degree in French, Spanish, or German. In addition to the credit requirements of the selected engineering major, students are required to complete courses in French, Spanish or German language and culture, and to intern and/or study in a French-, Spanish-, or German-speaking country. The College continues to expand the opportunities available for students to gain international exposure and experience, including a recently approved Certificate in International Engineering.

For additional information refer to: http://www.engr.psu.edu/AboutCOE/ugstudies_ip.aspx (http://www.engr.psu.edu/AboutCOE/ugstudies_ip.aspx)

CONCURRENT MAJORS PROGRAM IN ENGINEERING AND LIBERAL ARTS -- This program requires ten semesters of study, both in the College of Engineering and in the College of the Liberal Arts. Upon completion of the program, a B.S. in the selected College of Engineering major will be awarded by the College of Engineering and the B.A. in Letters, Arts, and Sciences (LAS) will be awarded by the College of the Liberal Arts.

To be eligible for the program, a student must be initially enrolled in either the College of Engineering or the College of the Liberal Arts. The student must file an application for entrance with the assistant dean for student services, College of Engineering, by the published deadline during the student's spring semester of the second year and with the associate dean for undergraduate studies, the College of the Liberal Arts. Concurrent major candidates are subject to the same criteria for admission to a participating major in the College of Engineering as all other students.

During the first six semesters, the student completes seventy credits of basic General Education and Bachelor of Arts degree requirements and 30 to 34 credits of basic engineering requirements. In the final four semesters, the student completes 12 LAS credits plus the remaining requirements for the selected College of Engineering major. The additional 24 major credits required for the LAS degree are double counted with credits required for the College of Engineering degree. The average concurrent major graduate completes 166 to 174 credits in order to qualify for both degrees. This program is available with all the majors in the College of Engineering with the exception of the ten-semester Architectural Engineering major.

3-2 PROGRAM WITH OTHER INSTITUTIONS AND ENGINEERING -- In the 3-2 Program, the student completes three academic years of study at one of several cooperating institutions (with which Penn State has signed agreements) and then transfers to Penn State for at least two additional academic years. Upon completion of the program, the student is awarded a degree by the first institution and the B.S. degree by Penn State. The program makes it possible for a student to spend the first three years at an institution near one's home, thus reducing expenses.

Arrangements for the 3-2 Program for selected majors are in effect with these institutions: Bloomsburg University of Pennsylvania, East Stroudsburg University of Pennsylvania, Edinboro University of Pennsylvania, Elizabethtown College, Elon University, Franklin and Marshall College, Inter American University of Puerto Rico, Juniata College, Kutztown University of Pennsylvania, Lebanon Valley College, Lock Haven University of Pennsylvania, Mansfield University of Pennsylvania, Millersville University of Pennsylvania, St. Francis College, St. Vincent College, Shippensburg University of Pennsylvania, Slippery Rock University of Pennsylvania, SUNY at Geneseo, Towson University, Waynesburg College, and West Chester University of Pennsylvania. Inquiries concerning admission should be made at these institutions.

For additional information refer to:

http://www.engr.psu.edu/ProspectiveStudents/Undergraduate/transfer_32.aspx
(http://www.engr.psu.edu/ProspectiveStudents/Undergraduate/transfer_32.aspx)

CONTINUING AND DISTANCE EDUCATION -- The Engineering Continuing and Distance Education, C&DE, office offers a broad range of programs for practicing engineers, other technical professionals and the public. Credit and noncredit programs for individuals or groups are available at the University Park campus and at other Penn State campuses and continuing education centers throughout Pennsylvania. Programs and courses are made available to audiences anywhere in the world through a variety of technologies, including the internet and interactive video. Engineering C&DE interfaces with the University Office for Outreach, providing design, production, and delivery of a growing list of courses. Students may take these courses while they are on Cooperative Education or Internship assignments; thus, allowing them to make academic progress toward their degree requirements while they are working off campus.

For additional information refer to: http://www.engr.psu.edu/AboutCOE/gstudies_cde.aspx
(http://www.engr.psu.edu/AboutCOE/gstudies_cde.aspx)

ENGINEERING DIVERSITY -- The Office of Engineering Diversity is committed to creating and enhancing a welcoming learning environment for all students in the College of Engineering. Through pre-college and bridge programs and coordination of recruitment, retention, networking and other programming, the Office strives to enhance the representation of women and underrepresented students in the undergraduate and graduate programs, as well as in the faculty and administration. The Multicultural Engineering Program and the Women in Engineering Program has evolved over the past 20 years and currently offer 20-25 programs annually that are designed to enhance diversity in the College.

For additional information refer to:

<http://www.engr.psu.edu/CurrentStudents/diversityprograms.aspx>
(<http://www.engr.psu.edu/CurrentStudents/diversityprograms.aspx>)

WOMEN IN ENGINEERING PROGRAM -- The Women in Engineering Program (WEP) is an academic support unit of the College of Engineering. WEP serves undergraduate and graduate women, faculty and alumnae, and undertakes extensive programming that supports the College mission, vision, and goals. Programming emphasizes active learning, academic achievement, leadership development, and community building. As such, it provides services and information that address its mission to recruit women into engineering, to facilitate the development of women engineers through advocacy and action, and to actively promote an equitable and productive learning and work environment within the College of Engineering. Activities include academic assistance, developmental course work, career development, industry networking, climate enhancement, mentoring, leadership development, scholarship and fellowship support, information dissemination, research into gender and assessment issues in engineering education and an external Advisory Board. WEP also offers an extensive program of K-12 camps and workshops, providing leadership opportunities for current students as it encourages future generations of engineers.

For additional information refer to: <http://www.engr.psu.edu/wep/> (<http://www.engr.psu.edu/wep/>)

MULTICULTURAL ENGINEERING PROGRAMS -- The Multicultural Engineering Program focuses on fostering a sense of community in the college. To enhance recruitment and retention, the program provides services designed to nurture supportive and collaborative relationships among students, faculty, staff, alumni, and industrial partners. These services include tutoring, seminars, pre-first-year summer programs, employment workshops and scholarships, with emphasis on proactively seeking out, guiding and preparing students for future success from high school through graduate school. The program promotes academic excellence, industrial and research experience, and personal and professional development.

For additional information refer to:

<http://www.engr.psu.edu/mep/About%20MEP/> (<http://www.engr.psu.edu/mep/About%20MEP/>)

ENTRANCE TO MAJOR -- In addition to the minimum grade point average (GPA) requirements described by University Policies, the College of Engineering has course requirements for admission to all its majors. To be eligible for consideration for entrance to a major, a student must have completed the following requirements with a minimum grade of C: CHEM 110 GN (or CMPSC 122 for the Computer Science major), MATH 140 GQ, MATH 141 GQ, and PHYS 211 GN. These must be completed by the end of the semester during which the admission to major process is carried out. Because the Engineering Science major is an honors program, admission is limited to students who attain a cumulative GPA of 3.0.

For additional information refer to:

http://www.engr.psu.edu/AdvisingCenter/StudentActions/sa_majentrance.aspx
(http://www.engr.psu.edu/AdvisingCenter/StudentActions/sa_majentrance.aspx)

The Executive Vice President and Provost of the University approves administrative enrollment controls that limit the number of students who may be admitted to some majors in the College of Engineering. In each case, however, academic requirements are established that guarantee a student's admission to those majors. For information on the majors for which enrollment is currently limited and their academic guarantees of admission, contact the Engineering Advising Center, 208 Hammond Building, University Park, PA 16802 (814-863-1033).

COLLEGE OF ENGINEERING

DAVID N. WORMLEY, *Dean*

ANTHONY A. ATCHLEY, *Associate Dean for Research and Administration*

RENATA S. ENGEL, *Associate Dean for Academic Programs*

JEAN LANDA PYTEL, *Assistant Dean for Student Services*

AMY L. FREEMAN, *Assistant Dean for Engineering Diversity*

COLLEGE ORGANIZATION

Acoustics -- ANTHONY A. ATCHLEY, *Chair*

Aerospace Engineering -- GEORGE A. LESIEUTRE, *Head*

Architectural Engineering -- CHIMAY J. ANUMBA, *Head*

Bioengineering -- HERBERT H. LIPOWSKY, *Head*

Biological Engineering (College of Agricultural Sciences) -- ROY E. YOUNG, *Head*

Chemical Engineering -- ANDREW L. ZYDNEY, *Head*

Civil and Environmental Engineering -- PEGGY A. JOHNSON, *Head*

Computer Science and Engineering -- RAJ ACHARYA, *Head*

Electrical Engineering -- W. KENNETH JENKINS, *Head*

Engineering Science and Mechanics -- JUDITH A. TODD, *Head*

Engineering Design, Technology, and Professional Programs, School of -- SVEN BILÉN, *Interim Head*

Industrial and Manufacturing Engineering -- PAUL M. GRIFFIN, *Head*

Mechanical and Nuclear Engineering -- KAREN A. THOLE, *Head*

Science, Technology, and Society -- GREG EGHIGIAN, *Director*

UNDERGRADUATE PROGRAM SUPPORT

Continuing and Distance Education -- TERRY J. REED, *Director*

Engineering Advising Center -- JEAN LANDA PYTEL, *Assistant Dean*

Engineering Assessment and Instructional Support -- SARAH E. ZAPPE, *Director*

Engineering Cooperative Education Program -- RICK D. McCLINTIC, *Director*

Leonhard Center for the Enhancement of Engineering Education -- THOMAS A. LITZINGER, *Director*

Office of Engineering Diversity -- AMY L. FREEMAN, *Assistant Dean*

Baccalaureate Degrees

Aerospace Engineering

University Park, College of Engineering (AERSP)

PROFESSOR GEORGE A. LESIEUTRE, *Head, Department of Aerospace Engineering*

This major emphasizes the analysis, design, and operation of aircraft and spacecraft. Students learn the theories and practices in the fundamental subjects of aeronautics, astronautics, aerodynamics and fluid dynamics, aerospace materials and structures, dynamics and automatic control, aircraft stability and control and/or orbital and attitude dynamics and control, air-breathing and rocket propulsion, aircraft systems design and /or spacecraft systems design. All of these place significant weight on the development and use of teamwork and communications skills for effective problem-solving. Graduates in aerospace engineering find employment in the customary settings such as government laboratories, large and small aerospace firms, and in nontraditional positions that also require the use of systems-engineering approaches to problem-solving; they can also pursue graduate study in aerospace engineering and related fields.

Graduates with a Bachelor of Science in Aerospace Engineering will be able to:

1. analyze the dynamics and control characteristics of aerospace vehicles, including the basic translational and rotational dynamics, and the basic theory and practice used to control these motions,
2. analyze fluid dynamics, including the regimes of subsonic, transonic, and supersonic flows, inviscid and viscous flows, and laminar and turbulent flows,
3. apply knowledge of the fundamentals of aeronautics, including aerodynamic characteristics of aircraft, propulsion systems, airplane performance, and elementary aircraft stability and control,
4. apply knowledge of the fundamentals of astronautics, including orbital mechanics, attitude dynamics and control, rocket propulsion, and the space environment,
5. predict performance, and conduct preliminary design, of gas turbine and rocket-based propulsion systems and their components,
6. analyze the detailed dynamics, stability, and control of either aircraft or spacecraft,
7. analyze and design structural elements such as bars, beams, plates, and thin-walled structures,
8. make measurements to test hypotheses or to characterize the performance of physical systems (aerodynamic, structural, and control), and analyze and interpret the data in written reports,
9. complete the successive stages of conceptual, preliminary, and detailed design of an aircraft or spacecraft mission and the associated vehicles,
10. function effectively on teams to solve problems in complex aerospace systems that require knowledge of multiple disciplines,
11. apply an understanding of professional and ethical responsibility to realistic situations,
12. make effective oral and written presentations in a format appropriate for the setting,
13. explain how this profession affects society as a whole, and to demonstrate an appreciation of how technical issues guide societal actions,
14. demonstrate an awareness of the need to stay abreast of technical developments throughout their working careers, and demonstrate that they are able to maintain and extend their learning, and
15. make appropriate and effective use of computer software, hardware, and state-of-the-art laboratory instrumentation.

The first two years of study are similar to those in other engineering majors and provide students with a basic education for the engineering profession. Students need to complete E MCH 212, CMPSC 201, MATH 220, MATH 230, and MATH 250 prior to the start of the junior year in order to meet graduation requirements in the following two years. Six of the nine technical-elective credits taken in the senior year must be aerospace engineering courses.

For the B.S. degree in Aerospace Engineering, a minimum of 131 credits is required. This baccalaureate program in Aerospace Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 113 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (72 credits)

CHEM 110 GN(3[1](#mnote01)), EDASN 100(3), MATH 140 GQ(4[1](#mnote01)), MATH 141

GQ(4[1](#mnote01)), PHYS 211 GN(4[1](#mnote01)) (Sem: 1-2)

E MCH 212(3[1](#mnote01)), M E 201(3), MATH 220 GQ(2-3), MATH 230(4), MATH 250(3), PHYS 212 GN(4),

PHYS 214 GN(2) (Sem: 3-4)

AERSP 301(3[1](#mnote01)), AERSP 304(3), AERSP 305W(3), AERSP 306([1](#mnote01)), AERSP

309(3[1](#mnote01)), AERSP 311(3[1](#mnote01)), AERSP 312(3), AERSP 313(3[1](#mnote01)), E MCH

315(2), E MCH 316(1) (Sem: 5-6)

AERSP 410(3), ENGL 202C GWS(3) (Sem: 7-8)

ADDITIONAL COURSES (29 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 1-2)

Select 5 credits from E MCH 210(5), E MCH 211(3), E MCH 213(3) (Sem: 3-4)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 3-4)

AERSP 401A(3), AERSP 401B(2); or AERSP 402A(3), AERSP 402B(2) (Sem: 7-8)

AERSP 413(3) or AERSP 450(3) (Sem: 7-8)

AERSP 440(3), E E 210(3), or E E 212(4) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 9 credits of Aerospace Technical Elective (ATE) courses from department list. (Sem: 7-8)

Select 3 credits of Limited Elective (LE) courses from department list. (Sem: 7-8)

(Students who complete Basic ROTC may substitute 6 of the ROTC credits for 3 credits of LE and 3 credits of GHA.)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 2006

Blue Sheet Item #: 34-05-056

Review Date: 2/28/06

UCA Revision #1: 8/2/06

UCA Revision #2: 7/26/07

EN

Architectural Engineering

University Park, College of Engineering (A E)

PROFESSOR CHIMAY J. ANUMBA, *Head, Department of Architectural Engineering*

This major emphasizes the application of scientific and engineering principles to the planning, design, and construction of buildings and building systems. The goal of the program is to provide engineering graduates with the best education available for careers in the building professions. Graduates will have the ability to practice as registered professional engineers in a variety of areas, both public and private, related to the planning, design, construction, and operation of buildings and to assume a place of leadership in society.

Four options are available in the ten-semester major: the Construction option, which emphasizes building construction engineering and construction management; the Lighting/Electrical option, which emphasizes the design of lighting and electrical systems for buildings; the Mechanical option, which emphasizes the design of heating, ventilating and air-conditioning systems in buildings; and the Structural option, which emphasizes the analysis and design of building structural systems. Courses in architectural design are included in all options to give the engineering student an understanding of architectural design and its relation to engineering. Courses in engineering design are provided throughout the program. The design experience is culminated in a year-long capstone design course.

A limited number of undergraduate students in the B.A.E. program will be considered for admission to the integrated undergraduate/graduate program leading to the B.A.E. and the M.A.E. degrees. Students who are currently enrolled in the 7th semester of the B.A.E. degree program may be admitted to the integrated B.A.E./M.A.E. program, following a positive review of an application specific to this program by the faculty committee on graduate admissions. Students must have attained a GPA of at least 3.0 and must have attained a grade of C or better in all classes listed as A E. Students admitted to the integrated program must maintain a GPA in all classes used toward the M.A.E. degree of at least 3.0.

The professional degree, Bachelor of Architectural Engineering, is granted upon the satisfactory completion of the five-year program.

Graduates, after several years in practice, are engaged in a professional career in the building industry as follows.

Graduates, with the appropriate experience, are qualified and competent to sit for the professional engineering exam.

Graduates are capable to meet the challenges of the engineering work environment. The graduates have assumed some leadership responsibilities.

Graduates are capable of solving design and project related problems based on sound engineering principles as demanded by their work.

Graduates are successfully conducting multi-disciplinary/inter-disciplinary interactions as required by their work.

Graduates are engaged in service activities in the public and professional realms.

For the B.A.E. degree in Architectural Engineering, a minimum of 160 credits is required. This baccalaureate program in Architectural Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700 www.abet.org (<http://www.abet.org>).

For the integrated B.A.E./M.A.E. degrees, a minimum of 172 credits of course work is required.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(33 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 148 credits

(This includes 33 credits of General Education courses: 9 credits of GN courses; 6 credits of GA courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 112 credits

PRESCRIBED COURSES (102 credits)

CHEM 110 GN(3[11(#mnote01)], CHEM 111 GN(1), E G 130(3), MATH 140 GQ([11(#mnote01)], MATH 141 GQ(4)[11(#mnote01)], PHYS 211 GN(4[11(#mnote01)]) (Sem: 1-2)
A E 202(3), A E 221(3), A E 222(3), ARCH 130A(6), E MCH 211(3), E MCH 213(3), MATH 220 GQ(2-3), MATH 231(2), PHYS 212 GN(4), PHYS 213 GN(2) (Sem: 3-4)
A E 308(4[11(#mnote01)], A E 309(3), A E 310(3[11(#mnote01)], A E 311(3[11(#mnote01)], A E 372(3[11(#mnote01)], A E 481W(4), A E 482(4), ARCH 210 GA(3), ARCH 211 GA(3), E E 211(3), E MCH 212(3), M E 201(3), MATH 250(3), STAT 401(3) (Sem: 5-6)
ARCH 441(3), ARCH 443(1) (Sem: 7-8)
ENGL 202C GWS(3) (Sem: 9-10)

ADDITIONAL COURSES (10 credits)

Select A E 124S(1) or 1 credit of another First-Year Seminar (Sem: 1-2)
ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

REQUIREMENTS FOR THE OPTION: 36 credits

CONSTRUCTION OPTION: (36 credits)

PRESCRIBED COURSES (24 credits)

A E 404(3), A E 475(3), A E 476(3), C E 336(3), C E 337(1), MGMT 326[191(#mnote19)] (Sem: 7-8)
A E 472(3), A E 473(3), C E 209(2) (Sem: 9-10)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits from technical courses on department list (Sem: 7-8)
Select 5 credits from technical courses on department list[191(#mnote19)] (Sem: 9-10)
Select 4 credits of geotechnical courses (Sem: 9-10)

LIGHTING/ELECTRICAL OPTION: (36 credits)

PRESCRIBED COURSES (24 credits)

A E 404(3), A E 454(3), A E 461(3), A E 467(3), ARCH 442[191(#mnote19)] (Sem: 7-8)
A E 444(3), A E 464(3), A E 466(3) (Sem: 9-10)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits from technical courses on department option list (Sem: 7-8)
Select 9 credits from technical courses on department option list [191(#mnote19)] (Sem: 9-10)

MECHANICAL OPTION: (36 credits)

PRESCRIBED COURSES (27 credits)

A E 404(3), A E 454(3), A E 455(3), A E 457(3), A E 467(3) ARCH 441[191(#mnote19)], M E 320(3), M E 410(3) (Sem: 7-8)
A E 458(3) (Sem: 9-10)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 3 credits from technical courses on department option list[191(#mnote19)] (Sem: 7-8)
Select 6 credits from technical courses on department option list (Sem: 9-10)

STRUCTURAL OPTION: (36 credits)

PRESCRIBED COURSES (23 credits)

A E 401(3), A E 402(3), A E 403(3), A E 430(3), ARCH 442[191(#mnote19)], E MCH 315(2), E MCH 316(1) (Sem: 7-8)
A E 431(3), C E 209(2) (Sem: 9-10)

SUPPORTING COURSES AND RELATED AREAS (13 credits)

Select 9 credits from technical courses on department list[191(#mnote19)] (Sem: 7-8)
Select 4 credits in Geotechnical (Sem: 7-8)

Note: The following substitutions are allowed for students attending campuses where the indicated course is not offered: ED&G 100(3) can be substituted for E G 130(3).

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.
[19] Students having successfully completed ROTC upon graduation, may apply 3 credits of ROTC to these courses. Additionally, 3 credits of ROTC may be applied to GHA.

Last Revised by the Department: Summer Session 2007

Blue Sheet Item #: 35-06-319

Review Date: 4/10/07

UCA Revision #1: 8/2/06

UCA Revision #2: 7/26/07

EN

Department head updated by Publications: 7/23/08

Bioengineering

University Park, College of Engineering (BIO E)

PROFESSOR HERBERT H. LIPOWSKY, *Head of the Department of Bioengineering*

The Bioengineering curriculum emphasizes the continuous integration of classical and modern engineering principles with the life sciences and health care. Bioengineers apply these skills to innovation in the health care industry, basic biological sciences, and the underpinning of medical practice.

Consistent with the mission of Penn State University and the College of Engineering, the Penn State Bachelor of Science program in Bioengineering aims to create world-class engineers who will, after graduation, contribute to social and economic development through the application of engineering to the solution of problems in medicine and biology.

Specific program objectives are that three to five years after graduation, graduates will be:

employed in industry positions which include, but are not limited to, research and development, manufacturing, quality assurance and sales and marketing, or,

enrolled in graduate school, continuing education, or other professional development programs related to biomedical sciences and engineering, or,

enrolled in medical school, dental school, or other health-related professional training programs.

For the B.S. degree in Bioengineering, a minimum of 132 credits is required. The baccalaureate program in Bioengineering at University Park is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org. (<http://www.abet.org/>)

Students in residence at the Commonwealth campuses may satisfy the course requirements for semesters 1-3. They should then transfer to University Park to begin studies in their major beginning with semester 4.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of the *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 114-115 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 94 credits**PRESCRIBED COURSES (75 credits)**

BIOL 141 GN(3), BIOL 142(1), EDSGN 100(3) (Sem: 1-2)

CHEM 110 GN(3^{[1](#mnote01)}), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1) (Sem: 1-2)

MATH 140 GQ(4^{[1](#mnote01)}), MATH 141 GQ(4^{[1](#mnote01)}), PHYS 211 GN(4^{[1](#mnote01)}) (Sem: 1-2)

BIOE 201(3^{[1](#mnote01)}) (Sem: 3-4)

CMPSC 201 GQ(3), E MCH 210(5) (Sem: 3-4)

MATH 230(4), MATH 251(4^{[1](#mnote01)}), PHYS 212 GN(4) (Sem: 3-4)

BIOE 301(3^{[1](#mnote01)}), BIOE 302(1), BIOE 303(3^{[1](#mnote01)}), BIOE 313(3^{[1](#mnote01)}), BIOE

401(3^{[1](#mnote01)}), BIOE 402(3^{[1](#mnote01)}), BIOE 403(1), BIOE 404(1) (Sem: 5-6)

ENGL 202C GWS(3) (Sem: 5-6)

BIOE 440(1), BIOE 450W(3) (Sem: 7-8)

ADDITIONAL COURSES (10 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 6 credits of BIOE courses (Sem: 7-8)

Select 3 credits of Science or Engineering Elective courses (Sem: 7-8)

REQUIREMENTS FOR THE OPTION: 20-21 credits**CHEMICAL ENGINEERING OPTION:(20 credits)****PRESCRIBED COURSES (9 credits)**

BIOE 409(3), BIOE 413(3) (Sem: 5-6)

BIOE 423(3) (Sem: 7-8)

ADDITIONAL COURSES (11 credits)

CHEM 202(3) or CHEM 210(3) (Sem: 6-8)

Select 8 credits from the following list. At least 3 credits in additional courses must be from the College of Engineering:

B E 468(3), B M B 401(3), B M B 402(3), B M B 437(2), BIOE 419(3), BIOE 443(3), BIOE 444 IL(3), CH E 340(3), CH E 438(3); CHEM 203(3), CHEM 212(3), CHEM 213(2), E SC 483(3), E SC 484(3), or other BIOE 400 and 500 level courses by petition. (Sem: 6-8)

ELECTRICAL ENGINEERING OPTION:(21 credits)**PRESCRIBED COURSES (11 credits)**

E E 210(4) (Sem: 3-4)

E E 310(4) (Sem: 5-6)

BIOE 406(3) (Sem: 7-8)

ADDITIONAL COURSES (4 credits)

E E 330(4), or CMPEN 271(3) and CMPEN 275(1) (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits from Electrical Engineering Option department list (Sem: 7-8)

MATERIALS SCIENCE OPTION:(20 credits)**PRESCRIBED COURSES (20 credits)**

CHEM 210(3), PHYS 214 GN(2) (Sem: 3-4)

MATSE 201(3), MATSE 443(3) (Sem: 5-6)

MATSE 403(3), MATSE 404 IL(3), MATSE 430(3) (Sem: 7-8)

MECHANICAL ENGINEERING OPTION:(20 credits)**PRESCRIBED COURSES (11 credits)**

E MCH 212(3), E MCH 315(2), E MCH 316(1), MATH 220 GQ(2) (Sem: 3-4)

BIOE 409(3) (Sem: 5-6)

ADDITIONAL COURSES (3 credits)

M E 360(3) or M E 370(3), MATSE 403(3) or MATSE 404 IL(3) (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits from Mechanical Engineering Option department list (Sem: 6-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 2008

Blue Sheet Item #: 36-06-067

Review Date: 4/15/08

UCA Revision #1: 8/2/06

UCA Revision #2: 7/26/07

EN

Biological Engineering

University Park, College of Agricultural Sciences

University Park, College of Engineering (B E)

PROFESSOR ROY E. YOUNG, *Head of the Department of Agricultural and Biological Engineering*

This major helps prepare students for careers involving the application of engineering principles to agricultural and biological production systems, processing systems, and conservation of land and water resources. Education in mathematics, physics, and engineering sciences common to all engineering disciplines is provided along with specialized training in biological and agricultural sciences. The curriculum covers all areas of agricultural and biological engineering, including food engineering, postharvest handling and processing of commodities, power and machinery development and applications, resource management and utilization, soil and water management, and structures and their environmental modifications, product synthesis using microbiological organisms, and food safety. A student can select the Agricultural Engineering option or the Biological and Food Engineering option.

Early career Biological Engineering graduates will:

1. Enter careers and/or advanced studies in bio-based production, processing, and sustainable environments;
2. Lead teams in analyzing and resolving technical challenges;
3. Qualify for pursuit of professional engineering registration; and
4. Keep abreast of contemporary issues in the field and workplace.

Design experiences are integrated throughout the junior-year curriculum by having students solve problems typical of those encountered in the agricultural and biological engineering profession. Two major design experiences in the senior year emphasize that agricultural and biological engineers must learn not only how to create and use the newest technology, but also to assess and manage the social and ethical consequences of that technology.

Careers for graduates include design, development, and research engineering positions involving food processing, machinery development, soil and water management, materials handling, biological product development, and structural systems for animals, plants, and crop storage. Agricultural and biological engineers are employed in industry, consulting firms, and governmental agencies in the United States and abroad. Graduates deal with the various engineering aspects associated with production and processing of food, fiber, and other biological materials, within the constraints of environmental protection and natural resource conservation.

For the B.S. degree in Biological Engineering, a minimum of 130 credits is required. The baccalaureate program in Biological Engineering at University Park is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org .

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(27-28.5 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 112-113.5 credits

(This includes 27-28.5 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses; and 1.5 credits of GHA courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 79 credits**PRESCRIBED COURSES (75 credits)**

CAS 100A GWS(3), CHEM 110 GN(3)[11(#mnote01)], CHEM 111 GN(1), E MCH 211(1)[11(#mnote01)], EDSGN 100(3), ENGL 015 GWS(3), MATH 140 GQ(1)[11(#mnote01)], MATH 141 GQ(4)[11(#mnote01)], PHYS 211 GN(4)[11(#mnote01)] (Sem: 1-2)
E MCH 212(3)[11(#mnote01)], E MCH 213(3)[11(#mnote01)], M E 300(3)[11(#mnote01)], MATH 231(2), MATH 251(4), PHYS 212 GN(4) (Sem: 3-4)
B E 300(3)[11(#mnote01)], B E 301(3)[11(#mnote01)], B E 302(3)[11(#mnote01)], B E 304(3)[11(#mnote01)], B E 305(3)[11(#mnote01)], B E 308(3)[11(#mnote01)], B E 391 GWS(2), I E 424(3), (Sem: 5-6)
B E 392 GWS(2), B E 469W(3) (Sem: 7-8)

ADDITIONAL COURSES (4 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

AG BM 101 GS(3) or ECON 002 GS(3), or ECON 004 GS(3) (Sem: 3-4)

REQUIREMENTS FOR THE OPTION: 33-34.5 credits**AGRICULTURAL ENGINEERING OPTION: 33 credits****PRESCRIBED COURSES (9 credits)**

B E 303(2)[11(#mnote01)], B E 306(2)[11(#mnote01)], B E 307(2)[11(#mnote01)], C E 360(3)[11(#mnote01)] (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS (24 credits)

Select 3 credits in math/basic science science[26](#mnote01)] (Sem: 3-6)

Select 6 credits in engineering science/design[26](#mnote01)] (Sem: 5-8)

Select 3 credits in agricultural/biological science[26](#mnote01)]

Select 6 credits in agricultural and biological engineering[26](#mnote01)] (Sem: 7-8)

Select 6 credits in technical selection[26](#mnote01)] (Sem: 7-8)

(Students may apply 3 credits of ROTC to the technical selection category and 3 credits to the GHA category upon completion of the ROTC program.)

BIOLOGICAL AND FOOD ENGINEERING OPTION 34.5 credits**PRESCRIBED COURSES (16.5 credits)**

B M B 211(3), CHEM 202(3), M E 320(3)[11(#mnote01)], NUTR 100 GHA(1.5) (Sem: 5-6)

B E 465(3), B E 468(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (18 credits)

Select 6 credits in emphasis technical elective[26](#mnote01)] (Sem: 7-8)

Select 6 credits in any engineering science/design[26](#mnote01)] (Sem: 7-8)

Select 6 credits in technical selection[26](#mnote01)] (Sem: 7-8)

(Students may apply 3 credits of ROTC to the technical selection category and 3 credits to the GHA category upon completion of the ROTC program.)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[26] Courses to be selected from a list approved by the Agricultural and Biological Engineering faculty.

These courses must be chosen so that the engineering design and engineering science requirements for the major are met.

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-06-039

Review Date: 4/14/09

UCA Revision #1: 8/2/06

[Comments\(http://www.psu.edu/bulletins/bluebook/contact \)](http://www.psu.edu/bulletins/bluebook/contact)

EN

Chemical Engineering

University Park, College of Engineering (CH E)

Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

PROFESSOR ANDREW L. ZYDNEY *Head, Department of Chemical Engineering*

Chemical Engineering is one of the most versatile professions--you'll find Chemical Engineers employed in a broad array of industries ranging from pharmaceutical and biotechnical companies to semiconductor manufacturing to start-up companies converting the latest laboratory discoveries to large-scale commercial production. Chemical Engineers work with catalysts to develop new ways to manufacture medicines and plastics; they develop control systems that enable the safe production of products from semiconductors to household soap; they design chemical and petroleum plants; they research the effects of artificial organs on blood flow; and they develop the equipment and processes necessary for advances in biotechnology. While chemistry emphasizes the facts and principles of science, chemical engineering emphasizes its practical application for the development of new products and processes.

The undergraduate program in Chemical Engineering provides students with fundamental skills in problem solving, analysis, and design, along with hands-on experience in practical applications. The curriculum builds upon the traditional foundation in the chemical and energy-related industries and introduces new material in the life sciences, polymers, and environmental fields. Students have numerous opportunities to pursue more specialized areas including formal options in Bioprocess and Biomolecular Engineering, Energy and Fuels, and Polymer Engineering.

The educational objectives of the undergraduate program in Chemical Engineering are specifically designed to produce graduates who will be able to:

1. identify and pursue their personal and professional goals using the foundation provided by the breadth of educational opportunities in chemical and biomolecular engineering offered at Penn State
2. pursue careers as practicing chemical engineers in traditional chemical and energy-related industries as well as in expanding areas of materials, environmental, biomedical, and biotechnology
3. apply their broad chemical engineering education--including their problem solving, analytical, design, research, and communication skills--in industry, government agencies, financial institutions, consulting firms, educational institutions, business, law, and medicine
4. provide the technical, educational, business, and political leadership needed in today's rapidly changing, increasingly technological, global society.

For the B.S. degree in Chemical Engineering, a minimum of 134 credits is required. This baccalaureate program in Chemical Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; o www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 116 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 98 credits

PRESCRIBED COURSES (85 credits)

CHEM 110 GN(3[11(#mnote01)], CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), EDSGN 100(3), MATH 140 GQ(4[11(#mnote01)], MATH 141 GQ(4[11(#mnote01)], PHYS 211 GN(4[11(#mnote01)] (Sem: 1-2)
B M B 251(3), CH E 210(3[11(#mnote01)], CH E 220(3[11(#mnote01)], CH E 300(1), CH E 320(3[11(#mnote01)], CH E 330(3[11(#mnote01)], CH E 340(3), CH E 350(3[11(#mnote01)], CH E 360(3), CHEM 210(3), CHEM 212(3), CHEM 213(2), CHEM 457(2), MATH 230(4), MATH 251(4), PHYS 212 GN(4) ENGL 202C GWS(3) (Sem: 3-6)
CH E 410(3[11(#mnote01)], CH E 430(3[11(#mnote01)], CH E 470(3), CH E 480W(3) (Sem: 7-8)

ADDITIONAL COURSES (13 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 1-6)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
Select 3 credits from: CHEM 448(3), or CHEM 452(3)(Sem: 5-6)

REQUIREMENTS FOR THE OPTION: 18 credits

BIOPROCESS AND BIOMOLECULAR ENGINEERING OPTION:18 credits

PRESCRIBED COURSES (6 credits)

B M B 252(3), CH E 449(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits from: B M B 442(3), BIOTC 479(3), BIOTC 489(3) (Sem: 5-8)
Select 9 credits from: B E 468(3), B M B 401(3), B M B 474(3), BIOE 419(3), BIOL 472(3), CH E 438(3), CH E 501(3[911(#mnote91)], MATSE 403(3), MICRB 201(3) (Sem: 7-8)

ENERGY AND FUELS OPTION: 18 credits

PRESCRIBED COURSES (3 credits)

EGEE 411(3) (Sem: 6)

SUPPORTING COURSES AND RELATED AREAS (15 credits)

Select 3 credits from: F SC 401(3), I H S 400(3) (Sem: 5)
Select 12 credits from: EGEE 420(3), EGEE 430(3), F SC 431(3), CH E/F SC 432(3), F SC 435(3), GEOEE 427(3), I S 420(3), I H S 450(3), I H S 445(3) I H S 470(3), I H S 447(3), P N G 410(3), P N G 480(3) (Sem: 7-8)

GENERAL OPTION: 18 credits

ADDITIONAL COURSES (18 credits)

Select 6 credits in 400-level CH E courses from department list (Sem: 5-8)
Select 6 credits of approved Engineering electives (Sem: 5-8)
Select 6 credits of approved Technical/Professional electives [311(#mnote31)] (Sem: 5-8)

POLYMER ENGINEERING OPTION(18 credits)

PRESCRIBED COURSES (9 credits)

MATSE 441(3), MATSE 443(3), MATSE 446(3) (Sem: 5-8)

ADDITIONAL COURSES (9 credits)

Select 3 credits from: MATSE 444(3), MATSE 445(3) (Sem: 5-8)
Select 6 credits from CH E 441(3), MATSE 447(3), MATSE 448(3) (Sem: 5-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.
[31] Students may substitute 6 credits of ROTC for part of this requirement in consultation with department.
[91] "...senior, undergraduate students with an average of at least 3.5, and certain other students with averages of at least 3.00 who have been granted special permission to enroll through the Office of Graduate Enrollment Services." Penn State University 2003-2004 Graduate Degree Programs Bulletin. Instructor approval is also required.

Last Revised by the Department: Summer Session 2005

Blue Sheet Item #: 33-07-013

Review Date: 10/6/05

UCA Revision #1: 8/3/06

Civil Engineering

Capital College (CE CA)

University Park, College of Engineering (C E)

PROFESSOR PEGGY JOHNSON, *Head, Department of Civil and Environmental Engineering*

The program in Civil and Environmental Engineering is designed to provide the basic undergraduate education required for private practice and public service in civil engineering, and/or continue formal education. Emphasis is placed on the fundamentals of civil engineering principles and design techniques. Students utilize basic engineering science concepts in several of the different specialty areas (e.g., construction/management, environmental, materials/pavement design/geotechnical, structures, transportation, and water resources). Finally the students are able to choose an area of specialization for professional practice or graduate studies.

The objective of the Civil Engineering program is to prepare students for a wide range of career paths that use civil engineering principles and methodologies. A curriculum is provided that prepares our recent graduates to:

work in industries or state and federal government agencies such as departments of transportation and departments of environmental protection that design, implement, and maintain national and/or global infrastructure;

effectively work in and lead interdisciplinary teams needed to design sustainable transportation, water, energy, environmental, and structural infrastructure; and

stay current through continuing education opportunities, professional conferences, and other self-learning experiences; have the ability to obtain and maintain professional licensing; and have the ability to attend graduate school.

The program is broadened by courses in communication, arts, humanities, social and behavioral sciences, as well as other engineering disciplines. Students gain experience in working as members of a team and using interdisciplinary approaches to solve problems. These experiences, as well as those related to engineering principles and design, are provided through exercises in the classroom, laboratory, and field. The program culmination is a capstone design course wherein the students' knowledge and skills are applied to actual engineering problems.

For the B.S. degree in Civil Engineering, a minimum of 130 credits is required. The baccalaureate program in Civil Engineering at University Park is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; o www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 112 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (63 credits)

CHEM 110 GN(3[[11\(#mnote01\)](#)], CHEM 111 GN(1), E MCH 211([[11\(#mnote01\)](#)], EDSGN 100(3), MATH 140

GQ(4)[1](#mnote01), MATH 141 GQ(4)[1](#mnote01), PHYS 211 GN(4)[1](#mnote01) (Sem: 1-2)
E MCH 212(3)[1](#mnote01), E MCH 213(3)[1](#mnote01), STAT 401(3), GEOSC 001(3), MATH 220
GQ(2-3), MATH 251(4), PHYS 212 GN(4) (Sem: 3-4)
C E 310(3)[1](#mnote01), C E 332(3)[1](#mnote01), C E 337(1), C E 340(3)[1](#mnote01), C E
360(3)[1](#mnote01), C E 370(3)[1](#mnote01), ENGL 202C GWS(3) (Sem: 5-6)

ADDITIONAL COURSES (40 credits)

C E 100S(1) or 1 credit of First-Year Seminar or elective (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 3-4)
ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 3-4)
M E 201(3) or CH E 220(3)[30](#mnote30) (Sem: 5-6)
C E 335(3)[1](#mnote01) or C E 336(3)[1](#mnote01) (Sem: 5-6)
E E 211(3) or E E 212(3)[30](#mnote30) (Sem: 7-8)
Select 15 credits from C E 321(3), C E 335(3), C E 336(3), C E 341(3), C E 342(3), C E 361(3), C E 371(3), C E
422(3), C E 423(3), C E 424(3), C E 432(3), C E 435(3), C E 436(3), C E 447(3), C E 462(3), C E 475(3), C E 476(
C E 479(1) (Sem: 5-8)[#](#mnote30)
Select 3 credits of C E 410W(3), C E 421W(3), C E 438W(3), C E 448W(3), C E 465W(3), C E 472W(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS: (9 credits)

Select 9 credits of technical elective from C E 300-level courses, C E 400-level courses, or department list.
(Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[30] Students may substitute 6 credits of ROTC for 3 credits of 400-level C E courses and 3 credits of M E or
E E.

[#] Those courses must be selected from at least 4 of the 5 technical areas in the Civil Engineering
program--transportation (x20), construction (x30), structures (x40), hydrosystems (x60), and environmental
(x70).

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-06-040

Review Date: 4/14/09

UCA Revision #1: 8/3/06

UCA Revision #2: 7/27/07

Publications dept head update: 7/14/06

EN

Computer Engineering

University Park, College of Engineering (CMPEN)

PROFESSOR RAJ ACHARYA, Head of the Department of Computer Science and Engineering

The mission of the faculty of the undergraduate Computer Engineering program at Penn State is to provide students with the knowledge and experience needed to pursue a productive lifelong career in industry or to engage in further study at the graduate level. Students participate in a balanced program of instruction covering the basic principles of the design and application of computer systems. The program includes coverage in breadth and depth in basic science, engineering, and abstract concepts of information handling. Students will specialize in and be prepared for careers in the design, analysis and use of hardware, software and systems. The program is structured to ensure that graduates have a clear understanding of the design and applications of computers, as well as the ability to apply this knowledge throughout their professional careers. In particular within a few years after graduation, graduates in computer engineering should be able to:

1. Successfully enter a technical graduate degree program.
2. Complete an assigned portion of a significant hardware/software project that meets the specifications and complies with time and budget constraints.
3. Lead a design team in a significant hardware and/or software project.
4. Function as an engineer or graduate student in an ethical manner.
5. Engage in lifelong learning, keeping up to date with current engineering practice, tools, and technologies.

6. Effectively collaborate with co-workers, customers, and partners in diverse environments.
7. Effectively articulate and defend a technical position.

For the B.S. degree in Computer Engineering, a minimum of 129 credits is required. This baccalaureate program in Computer Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 111 credits

(This includes 27 credits of General Education courses; 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (79 credits)

CHEM 110 GN(3[1](#mnote01), CHEM 111 GN(1), CMPSC 121(3)G([1](#mnote01), MATH 140 GQ(4), MATH 141 GQ(4[1](#mnote01), PHYS 211 GN(4[1](#mnote01), PHYS 212 GN(4) (Sem: 1-2)
CMPSC 122(3[1](#mnote01), CMPSC 221(3[1](#mnote01), CMPSC 360(3[1](#mnote01), CMPEN 362(3), E E 210(4[1](#mnote01), MATH 220 GQ(2-3), MATH 231(2), MATH 250(3), PHYS 214 GN(2) (Sem: 3-4)
CMPEN 331(3[1](#mnote01), CMPEN 431(3[1](#mnote01), CMPSC 311(3[1](#mnote01), CMPSC 465(3[1](#mnote01), E E 310(4[1](#mnote30), E E 353(3[1](#mnote01), ENGL 202C GWS(3), STAT 418(3) (Sem: 5-6)
CMPEN 482W(3), CMPSC 473(3) (Sem: 7-8)

ADDITIONAL COURSES (26 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
CMPEN 270(4[1](#mnote01); or CMPEN 271(3[1](#mnote01) and CMPEN 275(1) (Sem: 3-4)
ECON 002 GS(3), ECON 004 GS(3), ECON 014 GS(3), or E B F 200 GS(3) (Sem: 3-4)
Select 6 credits from CMPEN 411(3), CMPEN 416(3), CMPEN 417(3), CMPEN 454(3), CMPEN 455(3), CMPEN 471(3), CMPEN 472(3), CMPEN 473(3), CMPEN 475(3), E E 453(3), E E 456(3) (Sem: 5-8)
Select 6 credits from any 400-level CMPEN or CMPSC course (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits from department list (Students may apply up to 6 credits of ROTC and 3 credits of Co-op.)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 2008

Blue Sheet Item #: 36-05-059

Review Date: 2/26/08

UCA Revision #1: 8/3/06

UCA Revision #2: 7/27/07

EN

Computer Science

University Park, College of Engineering (CMPSC)

PROFESSOR RAJ ACHARYA, *Head of the Department of Computer Science and Engineering*

Computer Science is concerned with the analysis, design, and applications of computing software and systems. It includes a core foundation in computer hardware and software with emphasis on the design of

efficient, fault-free software. It includes programming languages, data structures, compilers, operating systems, databases, and artificial intelligence.

The major is designed to provide fundamental training in preparing graduates for positions in schools, commerce, industry, and government. Students should consult their advisers in formulating suitable programs.

For the B.S. degree in Computer Science, a minimum of 126 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(24 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 105-106 credits

(This includes 24 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (64 credits)

CMPSC 121 GQ(3)[\[1\]\(#mnote01\)](#), CMPSC 122(3)[\[1\]\(#mnote01\)](#), CMPSC 360(3)[\[1\]\(#mnote01\)](#), MATH 140 GQ(4)[\[1\]\(#mnote01\)](#), MATH 141 GQ(4)[\[1\]\(#mnote01\)](#), MATH 220 GQ(2), PHYS 211 GN(4)[\[1\]\(#mnote01\)](#), PHYS 212 GN(4) (Sem: 1-2)

CMPEN 271(3)[\[1\]\(#mnote01\)](#), CMPEN 331(3)[\[1\]\(#mnote01\)](#), CMPSC 221(3)[\[1\]\(#mnote01\)](#), CMPSC 311(3)[\[1\]\(#mnote01\)](#), MATH 230(4), STAT 318(3) (Sem: 3-4)

CMPSC 461(3)[\[1\]\(#mnote01\)](#), CMPSC 464(3), CMPSC 465(3)[\[1\]\(#mnote01\)](#), CMPSC 473(3)[\[1\]\(#mnote01\)](#), ENGL 202C GWS(3), STAT 319(3) (Sem: 5-6)

ADDITIONAL COURSES (19 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

Select 6 credits from CMPEN 362(3), CMPEN 431(3), CMPEN 454(3), CMPSC 442(3), CMPSC 450(3), CMPSC 451(3), CMPSC 455(3), CMPSC 456(3), CMPSC 458(3), CMPSC 466(3), CMPSC 467(3), CMPSC 468(3), CMPSC 471(3), E E 456(3) (Sem: 7-8)

Select 3 credits from any 400-level CMPEN or CMPSC course (Sem: 7-8)

Select 3 credits from CMPSC 431W(3), or CMPSC 483W(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (22-23 credits)

Select 2-3 credits from PHYS 213 GN(2), PHYS 214 GN(2), or 3 credits from the approved list of natural sciences courses (Sem: 3-4)

Select 0-4 credits in a foreign language (second-semester proficiency) (Sem: 5-6)

Select 10-14 credits from department list (Students may apply 6 credits of ROTC and 6 credits for Co-Op.) (Sem: 7-8)

Select 6 credits in 400-level non-CMPEN or CMPSC courses in consultation with adviser (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 2008

Blue Sheet Item #: 36-06-068

Review Date: 4/15/08

UCA Revision #2: 7/27/07

EN

Electrical Engineering

University Park, College of Engineering (E E)

PROFESSOR W. KENNETH JENKINS *Head of the Department of Electrical Engineering*

Electrical Engineering (E E) is one of the broadest of all engineering majors and is much more than just building electrical circuits. Electrical engineering is the application of electronics, electrical science and technology, and computer systems to the needs of society. An electrical engineer is responsible for designing and integrating electronic/electrical systems in diverse industries such as defense, communications, transportation, manufacturing, health care, construction, and entertainment.

The mission of our undergraduate program is to provide a high-quality education in electrical engineering for our students and to instill in them the attitudes, values, and vision that will prepare them for lifetimes of success, continued learning, and leadership in their chosen careers. A combination of required and elective courses ensures that students acquire a broad knowledge base in electrical circuits, digital systems, electronic devices, electromagnetics, and linear systems, as well as expertise in one or more areas of specialization. Additional problem-solving skills and practical experience are developed through design projects and laboratory assignments, which also provide opportunities for developing team-building and technical communication skills.

The BSEE Program provides undergraduates with the broad technical education necessary for productive employment in the public or private sector, and it develops in them an understanding of fundamentals and current issues important for future years of learning. Our program prepares students following graduation for:

1. Electrical engineering practice in technical assignments such as design, product development, research, manufacturing, consulting, testing, sales, and management;
2. Proficiency in the use of modern design tools;
3. Participation and leadership on teams comprised of individuals with diverse professional and cultural backgrounds;
4. Effective written and oral communication skills;
5. Appreciation of the implications of design in a global, societal, and ethical context;
6. Continued learning through such activities as graduate school, distance education, professional training, and membership in professional societies.

For the B.S. degree in Electrical Engineering, a minimum of 129 credits is required. This baccalaureate program in Electrical Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; o www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 111-113 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (65 credits)

CHEM 110 GN(3[1](#mnote01)), CHEM 111 GN(1), EDSGN 100(3), MATH 140 GQ([1](#mnote01)), MATH 141 GQ(4[1](#mnote01)), PHYS 211 GN(4[1](#mnote01)), PHYS 212 GN(4) (Sem: 1-2)

CMPEN 271(3[1](#mnote01)), CMPEN 275(1), E E 210(4[1](#mnote01)), E E 310(4[1](#mnote01)), E SC 314(3[1](#mnote01)), MATH 220 GQ(2), MATH 230(4), MATH 250(3), PHYS 213 GN(2), PHYS 214 GN(2) (Sem: 3-4)

E E 316(3[1](#mnote01)), E E 330(4[1](#mnote01)), E E 350(4[1](#mnote01)) (Sem: 5-6)

ENGL 202C GWS(3) (Sem: 7-8)

ADDITIONAL COURSES (19-21 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CMPSC 201 GQ(3) or CMPSC 121 GQ(3) (Sem: 1-2)

CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

ECON 002 GS(3) or ECON 004 GS(3) (Sem: 3-4)

Select 3-4 credits from I E 424(3), PHYS 410(3-4), STAT 401(3), STAT 414(3), or STAT 418(3) (Sem: 5-6)

E E 402W(3) or E E 403W(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (27 credits)

Select 6 credits from program-approved list of 300-level courses (Sem: 5-6)

Select 6 credits from program-approved lists of 300-level or 400-level courses (Sem: 5-6)

Select 6 credits from program-approved list of 400-level courses (Sem: 7-8)

Select 3 credits of engineering /science courses from a program-approved list (Sem: 7-8)

Select 6 additional credits, which may include up to 6 credits of ROTC, up to 6 co-op credits, and others from a program-approved list (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 2008

Blue Sheet Item #: 36-06-069

Review Date: 4/15/08

UCA Revision #1: 8/16/06

UCA Revision #2: 7/27/07

EN

Engineering Science

University Park, College of Engineering (E SC)

*PROFESSOR JUDITH A. TODD, Head of the Department of Engineering Science and Mechanics, P. B. Breneman
Department Head Chair*

Engineering Science is a multidisciplinary honors program that emphasizes enhanced understanding and integrated application of engineering, scientific, and mathematical principles. The program is unique because it provides a broad foundation in the sciences and associated mathematics that underlie engineering and provides students the opportunity to obtain a depth of knowledge in an area of their choosing through technical electives and an honors thesis. The curriculum is designed for students who seek to link the engineering disciplines with science. In addition to taking core courses in mathematics, physics, chemistry, and biology, students study thermodynamics, heat transfer, electromagnetics, solid and fluid mechanics, electrical devices, materials science, and failure analysis. During the senior year, all students select a focus area of study, complete a capstone project and write a thesis that integrates the scientific principles of research, design and analysis and applies them to engineering. Focus areas of study include, but are not limited to, electrical, mechanical, civil, bioengineering, and materials and are typically interdisciplinary. Hence, Engineering Science students achieve both depth and breadth in engineering and science, are able to function across disciplines, and graduate well prepared for advanced studies as well as professional employment.

The specific program objectives are tied to the mission of the program as described above. They target the major outcomes expected of Engineering Science students and are flexible and readily adaptable to meet changing constituent needs.

The expected accomplishments of Engineering Science graduates in the first several years following graduation are:

1. Participate in lifelong learning activities including, but not limited to, masters, doctorate, medical, and law degrees, continuing education, leadership development, management training, and global involvement/awareness.
2. Engage in practice in a wide variety of fields including, but not limited to, electrical systems, electronics, mechanical systems, materials development, forensics, biomaterials, medicine, law, and business.
3. Research, develop, design and/or utilize new products, processes, materials, devices, systems, and/or tools.
4. Communicate findings and best practices at conferences and meetings, by filing patents, in technical publications (journals, reports, memoranda), and to the general public.
5. Use state-of-the-art tools for the benefit of society.
6. Participate in and promote the value of diversity in society.
7. Encourage and foster future generations of engineers through mentoring, service, and outreach.

Enrollment is limited to students who have demonstrated that they can benefit from the advanced courses of the curriculum. A minimum grade-point average of 3.0 is partial demonstration of such competence. Qualified students can participate in the integrated undergraduate program to streamline the process of earning B.S. and M.S. degrees.

For the B.S. degree in Engineering Science, 131 credits and a 2.50 grade-point average are required. This baccalaureate program in Engineering Science is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 113 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (65 credits)

CHEM 110 GN(3[11(#mnote01)], CHEM 111 GN(1), EDSGN 100(3), MATH 140 GQ([11(#mnote01)], MATH 141 GQ(4[11(#mnote01)], PHYS 211 GN(4[11(#mnote01)] (Sem: 1-2)
MATH 220 GQ(2-3), MATH 230(4), MATH 251(4), PHYS 212 GN(4), PHYS 214 GN(2) (Sem: 3-4)
E E 210H(4), E E 340(3), E SC 312(3), E SC 407H[11(#mnote01)], E SC 414M(3[11(#mnote01)], E SC 433H(1),
M E 302(4) (Sem: 5-6)
E SC 404H(3[11(#mnote01)], E SC 410H(3), E SC 411H(3), ENGL 202C GWS(3) (Sem: 7-8)

ADDITIONAL COURSES (21 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
E SC 261M(3) or CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 1-2)
ECON 002 GS(3), ECON 004 GS(3), or ECON 014 GS(3) (Sem: 1-2)
E MCH 110H(5[11(#mnote01)] or E MCH 210(5[11(#mnote01)]; E MCH 112H(3[11(#mnote01)] or E MCH 212(3[11(#mnote01)] (Sem: 3-4)

SUPPORTING COURSES AND RELATED AREAS (27 credits)[321(#mnote32)

Select 3 credits from the department Foundational Elective List (Sem: 1-2)
Select 12 credits from the department Foundational Elective List (Sem:5-6)
Select 12 credits from the department Technical Elective List (Students may apply 3 credits of ROTC or 3 credits of co-op experience.) (Sem: 7-8)

Integrated Undergraduate/Graduate Study - B.S. Engineering Science-M.S. Engineering Science

Engineering Science students, because of the flexibility of the curriculum and their strength in fundamentals, have a unique opportunity to take advantage of the ESM Integrated Undergraduate Graduate (IUG) program. Application for IUG status may be made in the fifth or subsequent semesters.

ITJG status permits students to take on the rigors and research challenges of graduate study at Penn State, coordinating and combining them with their baccalaureate studies. Because some credits earned as an undergraduate may be applied to both degree programs, the time required for completion of integrated undergraduate/graduate studies is normally less than that required to complete separate degree programs. The actual time required is determined by the individual student's objectives, needs, and diligence.

Integrated Undergraduate/Graduate Study - B.S. Engineering Science-M.S. Engineering Mechanics

Engineering Mechanics students, because of the flexibility of the curriculum and their strength in fundamentals, have a unique opportunity to take advantage of the ESM Integrated Undergraduate Graduate (IUG) program. Application for IUG status may be made in the fifth or subsequent semesters.

IUG status permits students to take on the rigors and research challenges of graduate study at Penn State, coordinating and combining them with their baccalaureate studies. Because some credits earned as an undergraduate may be applied to both degree programs, the time required for completion of integrated undergraduate/graduate studies is normally less than that required to complete separate degree programs. The actual time required is determined by the individual student's objectives, needs, and diligence.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.
[32] Three credits in engineering science, 2 credits in engineering design.

Last Revised by the Department: Summer Session 2006 (E SC); Summer Session 2005 (Integrated B.S./E.Sc.-M.S./E.Mch. & Integrated B.S./E.Sc.-M.S./E.Sc. AND Program Description)

Blue Sheet Item #: 34-04-028 (E SC); 33-04-176, 33-04-177 (Add Integrated B.S./E.Sc.-M.S./E.Mch. & Integrated B.S./E.Sc.-M.S./E. Sc.)

Review Date: 01/17/06

UCA Revision #1: 8/3/06

UCA Revision #2: 7/27/07

EN

Industrial Engineering

University Park, College of Engineering (I E)

PROFESSOR RICHARD J. KOUBEK, *Head, Harold and Inge Marcus Department of Industrial and Manufacturing Engineering*

The undergraduate program in industrial engineering, being the first established in the world, has a long tradition of providing a strong, technical, hands-on education in design, control, and operation of manufacturing processes and systems. The curriculum provides a broad-based education in manufacturing, operations research and ergonomics through a base of mathematics, physical and engineering sciences, and laboratory and industrial experiences. It builds a strong foundation for the development of a professionally competent and versatile industrial engineer, able to function in a traditional manufacturing environment as well as in a much broader economy, including careers in financial services, communication, information technology, transportation, health care, consulting, or academia.

We expect our graduates to:

1. Participate in and lead cross-functional teams, designing, implementing and improving processes and systems in the manufacturing, service, or government sectors;
2. Work effectively in managerial and leadership positions;
3. Work and communicate effectively with internal and external team members in the global environment; and
4. Engage in continuous learning through varied work assignments, graduate school, professional training programs, and independent study.

The following outcomes are included in the courses taught in the program:

1. Management and Information Systems for Industrial Engineering; apply time value of money to make financial decisions and understand cost-accounting principles; understand probability concepts applicable to solve engineering problems; including reliability issues; conduct tests of hypotheses, create regression models and understand and apply statistical quality control methods such as process capability and control charts; formulate, solve and analyze real problems using Markov chains, network models, dynamic programming, queuing theory and inventory models; create simulation models of manufacturing and service systems and analyze simulation output; and gain an in-depth knowledge of implementation-related issues and theoretical aspects of database and Web-based operations related to industrial engineering.
2. Manufacturing Engineering: understand information contained in typical specifications and methods of product verification and conformance to specifications; and program flexible manufacturing equipment and system controllers; design logical manufacturing layouts and implement contemporary systems issues.

3. Human Factors: analyze and design both the job and the work site in a cost-effective manner, as well as measure the resulting output; understand and apply cognitive systems engineering: identify visual, auditory, cognitive, perceptual and environmental aspects of human performance, perform task analysis and evaluate human-computer interfaces; and perform work measurement, develop an MTM analysis and carry out a work sampling study.
4. General: present engineering study results in technical reports and in oral presentations, demonstrate life-long learning by synthesizing information from several sources, work effectively in groups on case studies and projects, demonstrate knowledge of contemporary issues, understand professional and ethical responsibility and the impact of engineering decisions in a global and societal context; and 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.

After completing courses required for the core and fundamental competencies in the major, students can choose one of the following three tracks for specialization:

Manufacturing Systems Engineering, Service Systems Engineering, and Engineering Information Systems.

A total of 9 course credits in each of the three tracks from the approved list is required, in addition to the three-credit capstone design course.

For the B.S. degree in Industrial Engineering, a minimum of 129 credits is required. This baccalaureate program in Industrial Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org (<http://www.abet.org>).

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 111 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (74 credits)

CHEM 110 GN(3[1](#mnote01)), CHEM 111 GN(1), EDSGN 100(3), MATH 140 GQ([1](#mnote01)), MATH 141 GQ(4[1](#mnote01)), PHYS 211 GN(4[1](#mnote01)) (Sem: 1-2)
E MCH 210(5[1](#mnote01)), ENGL 202C GWS(3), MATH 220 GQ(2-3), MATH 231(2), MATH 250(3), PHYS 212 GN(4) (Sem: 3-4)
I E 302(3[1](#mnote01)), I E 305(3[1](#mnote01)), I E 322(3[1](#mnote01)), I E 323(3[1](#mnote01)), I E 327(3[1](#mnote01)), I E 330(3[1](#mnote01)), I E 405(3[1](#mnote01)), MATSE 259(3) (Sem: 5-6)
I E 425(3), I E 453(3), I E 470(3), I E 480W(3) (Sem: 7-8)

ADDITIONAL COURSES (16 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 1-2)
ECON 002 GS(3) or ECON 004 GS(3) (Sem: 1-2)
I E 408(3) or I E 419(3) (Sem: 7-8) *The course not taken to satisfy this requirement can be taken as a track elective. Please see the list in (iv) of section C.)*

SUPPORTING COURSES AND RELATED AREAS (21 credits)

Select 3 credits as a science selection from department list (Sem: 3-4)
Select 6 credits as non-major electives from department list (Sem: 3-8)
Select 3 credits in manufacturing processes from department list. (Sem: 5-6) *(The courses not taken to satisfy this requirement can be taken as track electives. Please see the lists in (iii) and (iv) of Section C.)*
Select 9 credits for the track selected from department list (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-06-041

Review Date: 4/14/09

UCA Revision #1: 8/8/06

UCA Revision #2: 7/27/07

EN

Liberal Arts and Earth and Mineral Sciences Concurrent Degree Program

Liberal Arts and Engineering Concurrent Degree Program

ASSOCIATE DEAN JOHN L. SELZER *in charge*

These programs require ten semesters of study, concurrently in the College of the Liberal Arts (during which the student completes 70 credits in General Education and Bachelor of Arts requirements and 33 to 37 basic engineering or science requirements), and in either the College of Earth and Mineral Sciences or the College of Engineering (during which the student completes the credits required in the selected major in Earth and Mineral Sciences or Engineering).

Upon completion of the program, the B.A. in General Arts and Sciences will be awarded by the College of the Liberal Arts and the B.S. by the College of Earth and Mineral Sciences or the College of Engineering. The majors available in the College of Earth and Mineral Sciences are Environmental Systems Engineering, Geosciences, Mining Engineering, Polymer Science, Mineral Economics, Petroleum and Natural Gas Engineering, Ceramic Science and Engineering, Metals Science and Engineering, or Meteorology. The majors available in the College of Engineering are Aerospace, Agricultural, Chemical, Civil, Electrical, Environmental, Industrial and Management Systems, Mechanical, or Nuclear Engineering, or Engineering Science. [\[44\]\(#mnote44\)](#)

To be eligible for this program, a student must file an application for entrance with the associate dean for undergraduate studies, College of the Liberal Arts, not later than the third semester. Entrance to the program requires that the student satisfy all regular requirements of the College of the Liberal Arts and the College of Earth and Mineral Sciences or the College of Engineering. In addition, special requirements may need to be satisfied when enrollment controls are imposed on programs in any of the colleges because of space limitations. Once a student has met all the requirements for entrance to this program, transfer from the College of the Liberal Arts to the College of Earth and Mineral Sciences or the College of Engineering, with enrollment in one of the majors listed, will be approved automatically at the end of the sixth semester if the student continues to make normal progress toward the concurrent degree and has maintained a cumulative average of 2.00 or higher. Students entering majors in the College of Engineering must complete the following courses with a grade of C or higher: CHEM 110 GN(3) and CHEM 111 GN(1), MATH 140 GQ(4), MATH 141 GQ(4), and PHYS 201 GN(4), and meet the required cumulative grade-point average for the requested engineering major.

Students are advised of the absolute necessity for scheduling classes in exact sequence during the first six semesters of Concurrent Degree study. It is imperative that students obtain, from the Liberal Arts Undergraduate Studies Office, 101 Sparks Building, a copy of the Concurrent Degree requirements worksheet that enumerates the specific course requirements for the two programs for semesters one through six.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description for General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

BACHELOR OF ARTS DEGREE REQUIREMENTS: 24 credits

(3 of these 24 credits are included in the REQUIREMENTS FOR THE MAJOR, GENERAL EDUCATION, or ELECTIVES and 0-12 credits are included in ELECTIVES if foreign language proficiency is demonstrated by examination.) (See description of Bachelor of Arts Degree Requirements in this bulletin.)

REQUIREMENTS FOR THE MAJOR: 12 credits

EARTH AND MINERAL SCIENCES OR ENGINEERING COMPONENT: 89-91 credits

(This includes 15 credits of General Education courses: 6 credits of GQ courses and 9 credits of GN courses.)

SEMESTERS ONE THROUGH SIX (33-34 credits [\[45\]\(#mnote45\)](#))

PRESCRIBED COURSES (27 credits)

CHEM 111 GN(1), CHEM 113 GN(1), MATH 220 GQ(2-3), MATH 230(4), MATH 250(3) (Sem: 1-4)

E G 010(1), E G 011(1) (Sem: 3-4)

PHYS 201 GN(4), PHYS 202 GN(4) (Sem: 3-6)

E MCH 211(3), E MCH 212(3) (Sem: 5-8)

ADDITIONAL COURSES (6-7 credits)

PHYS 203 GN(3) or PHYS 204 GN(4) (Sem: 3-6)

B.S. requirements [\[46\]\(#mnote46\)](#) (3) (Sem: 5-6)

SEMESTERS SEVEN THROUGH TEN (56-57 credits)

Credits required in the selected major in Earth and Mineral Sciences or Engineering (56-57) (Sem: 7-10)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits from each of the following areas: arts, humanities, science/mathematics, social and behavioral sciences. (Sem: 9-10)

[44] Enrollment in the Engineering Science program is limited to those students attaining an average of B or higher during their first six semesters and to those specially chosen by the College of Engineering faculty on the basis of evidence that they will benefit from the advanced courses.

[45] Concurrent Degree candidates should consult the individual program requirements in the College of Engineering and the College of Earth and Mineral Sciences to ascertain which combinations of CHEM, E G, E MCH, MATH, and PHYS are required.

[46] Concurrent Degree candidates should select a course in this category appropriate for the requirements for their program in either Earth and Mineral Sciences or Engineering.

Last Revised by the Department: Summer Session 1991

Blue Sheet Item #: 16-10-030

Review Date: 5/22/08

UCA Revision #1: 8/8/06

Mechanical Engineering

University Park, College of Engineering (M E)

PROFESSOR KAREN A. THOLE; *Head, Department of Mechanical and Nuclear Engineering*

Mechanical Engineering is the science of understanding, and art of design of mechanisms and engines. Mechanisms are devices composed of solid, fluid, electrical, and optical components that perform specified tasks. Examples include: robots, tape drives, earth movers, clocks, sports equipment, energy-absorbing bumpers, acoustic sensors, low-friction bearings, high-friction brakes, automated inspection equipment, satellite positioners, and artificial hips. Engines are devices that convert (or conserve) thermal and mechanical energy to perform specified tasks. Examples include: internal combustion engines, jet engines, missile launchers, heat exchangers, refrigerators, ovens, ventilators, pumps, turbines, solar heaters, compressors, hydraulic actuators, and explosively deployed air bags.

The Mechanical Engineering program prepares students for a rewarding career in one of the broadest engineering disciplines. Since the industrial revolution, mechanical engineers have found themselves at the forefront of technology development and applications.

The objective of the Mechanical Engineering program is to prepare students for a wide range of career paths that use mechanical engineering principles and methodology. We will maintain and provide a curriculum that prepares our recent graduates for:

1. working in industry and government including computer-aided design, simulation and analysis of products or systems, experimentation and testing, manufacturing, and technical sales.
2. assuming increasing levels of responsibility in project, personnel, and budget management.
3. working and leading effectively in multi-disciplinary and multi-cultural teams.
4. communicating effectively and recognizing the global, social and ethical contexts of their work.
5. entering into graduate and professional studies.

The program offers a balance of engineering applications and theory with an emphasis on design from the first year through the industry-based capstone design experience in the senior year. In addition, mechanical engineering students find it easy to incorporate co-operative educational experiences as well as many minors into their program.

For the B.S. degree in Mechanical Engineering, a minimum of 131 credits is required. This baccalaureate program in Mechanical Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 113 credits

(This includes 27 credits of General Education courses; 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (80 credits)

CHEM 110 GN(3[1](#mnote01)), EDSGN 100(3), MATH 140 GQ(4[1](#mnote01)), MATH 141 GQ(4[1](#mnote01)), PHYS 211 GN(4[1](#mnote01)) (Sem: 1-2)
E MCH 211(3[1](#mnote01)), E MCH 212(3[1](#mnote01)), E MCH 213(3[1](#mnote01)), M E 300(3[1](#mnote01)), MATH 220 GQ(2-3), MATH 231(2), MATH 251(4), PHYS 212 GN(4), PHYS 214 GN(2) (Sem: 3-4)
E E 212(3), E MCH 315(2), ENGL 202C GWS(3), M E 320[1](#mnote01), M E 340(3[1](#mnote01)), M E 345(4[1](#mnote01)), M E 360(3[1](#mnote01)), M E 370(3[1](#mnote01)), M E 410(3[1](#mnote01)), MATSE 259(3) (Sem: 5-6)
I E 312(3), M E 450(3[1](#mnote01)) (Sem: 7-8)

ADDITIONAL COURSES (21 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)
CHEM 112 GN(3), or BIOL 141 GN(3) (Sem: 1-2)
ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
ECON 002 GS(3), ECON 004 GS(3), ECON 014 GS(3), or E B F 200 GS(3) (Sem: 1-2)
CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)
CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 3-4)
M E 440W(3) or M E 441W(3) (Sem: 7-8)
Select 2 credits from M E 325(1), M E 315(1), M E 375(1), M E 355(1), or E MCH 316(1) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits in a 400-level M E Technical Elective course excluding M E 410(3), M E 440W(3), M E 441W(3), M E 450(3), M E 494(1-9), and M E 496(1-18) (Sem: 5-8)
Select 6 credits in Engineering Technical Elective courses, any 400-level courses in the College of Engineering not required for a B.S. in M.E. (Sem: 5-8)
Select 3 credits in General Technical Elective courses from department list (Sem: 7-8)
(Students who complete Basic ROTC may substitute 6 of the ROTC credits for 3 credits of GTE and 3 credits of GHA.)
Three rotations of Engr Co-op (ENGR 295, ENGR 395, and ENGR 495) can be used as 3 credits of GTE.

Integrated B.S. and M.S. in Mechanical Engineering

A limited number of undergraduate students in the B.S.M.E. program will be considered for admission to the integrated undergraduate/graduate program leading to the B.S.M.E. and the M.S.M.E. degrees. Students with a junior standing in the B.S.M.E. degree program may be admitted to the integrated B.S.M.E./M.S.M.E. program, following a positive review of an application specific to this program by the faculty committee on graduate admissions. Students must have attained a GPA of at least 3.0. Students admitted to the integrated program must maintain a GPA in all classes used toward the M.S.M.E. degree of at least 3.0.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2008

Blue Sheet Item #: 36-01-039

Review Date: 8/28/07

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

Dept Head update by Publications: 8/1/06

[Comments\(http://www.psu.edu/bulletins/bluebook/contact \)](http://www.psu.edu/bulletins/bluebook/contact)

EN

Nuclear Engineering

University Park, College of Engineering (NUC E)

PROFESSOR KAREN A. THOLE, *Head, Department of Mechanical and Nuclear Engineering*

PROFESSOR JACK S. BRENIZER, JR. *Program Chair, Nuclear Engineering Program*

The overall educational objective of the Nuclear Engineering program is to prepare our graduates to function effectively in the marketplace in a wide range of career paths in Nuclear Engineering. The technical part of the curriculum, emphasizes power engineering, which refers to complex systems used to generate electricity. Because our emphasis in power engineering is strong, and because a shortage for this expertise exists in the industry, generally the industry values our graduates highly. We recognize that nuclear science is an important growth area. We constantly assess and review the needs of our undergraduate students and their most frequent employers and use this feedback to consider revisions to our curriculum so that it is responsive to the needs of our constituents.

Accordingly, we will maintain and provide a curriculum that prepares our graduates such that:

Work effectively in multidisciplinary and multicultural teams, communicate effectively and recognize the global, societal and ethical aspects of their work.

Within two to three years of graduation, the majority of our B.S. graduates are expected to:

be working in industry, especially power engineering,

be working in government agencies or national laboratories,

be pursuing advanced degrees.

After five to ten years we expect that many of our graduates will have established strong records of achievement at various technical and managerial levels in industry and government.

The first two years of the program stress fundamentals in mathematics, chemistry, physics, computer programming, and engineering sciences such as mechanics, materials, and thermodynamics. The last two years provide the breadth and depth in nuclear science, behavior of heat and fluids, reactor theory and engineering, and radiation measurement. The laboratory work includes experiments using the University's 1,000-kilowatt research reactor. Engineering design is incorporated in many courses from the freshman year to the senior year, but is particularly emphasized in the senior capstone design course, which integrates the critical elements of reactor theory, reactor engineering, safety considerations and economic optimization into a reactor design.

Many graduates are employed by electric power companies that use nuclear power plants, or by companies that help service and maintain those plants. They use their knowledge of engineering principles, radioactive decay, interactions of radiation with matter, and nuclear reactor behavior to help assure that the power plants meet the demand for reliable, economic electricity while ensuring a safe environment. To do this, graduates must be problem solvers who can develop and use complex computer models and sophisticated monitoring systems, design systems to handle radioactive waste, determine if the materials in the plant are becoming brittle or corroded, or manage the fuel in the reactor to get the maximum energy from it. Other graduates work in industries that use radioactivity or radiation to detect problems or monitor processes. Jobs are also found in branches of the government as designers of the next generation of reactors for submarines, aircraft carriers, or space probes, or to manage and clean up contaminates wastes. They could also be involved with regulation of nuclear power or radiation uses, or in research to develop advanced technologies that will be used in next-generation power plants. Graduates who want to further their education in the fields of health physics, radiation biology, or nuclear medical applications find this degree to be a useful preparation.

For the B.S. degree in Nuclear Engineering, a minimum of 129 credits is required. This baccalaureate program in Nuclear Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700; or www.abet.org.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 111 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (89 credits)

CHEM 110 GN(3[1](#mnote01), CHEM 111 GN(1), EDSGN 100(3), MATH 140 GQ([1](#mnote01), MATH 141 GQ(4[1](#mnote01), PHYS 211 GN(4[1](#mnote01), PHYS 212 GN(4) (Sem: 1-2)
E MCH 211(3), E MCH 212(3), E MCH 213(3), M E 300(3), MATH 230(4), MATH 251[1](#mnote01), PHYS 214 GN(2) (Sem: 3-4)
E E 212(3), E MCH 315(2), E MCH 316(1), M E 320(3), M E 410(3), NUC E 30[1](#mnote01), NUC E 302(4[1](#mnote01), NUC E 309(3[1](#mnote01), NUC E 450(3[1](#mnote01) (Sem: 5-6)
ENGL 202C GWS(3), NUC E 310W(2), NUC E 403(3), NUC E 430[1](#mnote01), NUC E 431W(4), NUC E 451(3) (Sem: 7-8)

ADDITIONAL COURSES (19 credits)

Select 1 credit of First-Year Seminar (Sem: 1-2)

ECON 002 GS(3), ECON 004 GS(3), ECON 014 GS(3) or E B F 200 GS(3) (Sem: 1-2)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CAS 100A GWS(3) or CAS 100B GWS(3) (Sem: 3-4)

CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 3-4)

Select 6 credits, of which 3 credits must be designated as design, from BIOE 406(3), NUC E 405, NUC E 407(3), NUC E 408, NUC E 409, NUC E 420, NUC E 428, NUC E 444, NUC E 445, NUC E 460(3), NUC E 470(3), NUC E 490, NUC E 496(1-18), NUC E 497(1-9) or 500-level NUC E courses with approval of adviser (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (3 credits)

(These courses may have to be chosen so that the engineering design or engineering science requirements for the major are met.)

Select 3 credits in General Technical Elective (GTE) courses from department list. (Sem: 7-8)

(Students who complete Basic ROTC may substitute 6 of the ROTC credits for 3 credits of GTE and 3 credits of GHA.)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Spring Semester 2008

Blue Sheet Item #: 36-01-040

Review Date: 8/28/07

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

Dept head update by Publications: 8/1/06

[Comments\(http://www.psu.edu/bulletins/bluebook/contact \)](http://www.psu.edu/bulletins/bluebook/contact)

EN

Associate Degrees

Minors

Agricultural and Biological Engineering Minor

University Park, College of Agricultural Sciences

University Park, College of Engineering (A B E)

This minor provides students with an opportunity to apply engineering principles to agricultural and biological production and processing systems and to the management of our natural resources. Courses may be selected by students to gain a better understanding of soil conservation and water quality, food and biological process engineering, structures and their environments, power and machinery, or microbiological engineering.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18-20 credits

PRESCRIBED COURSES (3 credits)

B E 300(3) (Sem: 5-6)

ADDITIONAL COURSES (15-17 credits)

Select 5-6 credits from B E 301(3), B E 302(3), B E 303(2), B E 304(3), B E 305(3), B E 306(2), B E 307(2), B E 308(3) (Sem: 5-8)

Select 10-11 credits from one of the following areas; one course marked with * must be selected (Sem: 5-8)

(a) Power and Machinery Systems: B E 461(3)*, A S M 420(3), A S M 424(3), M E 431, M E 480(3)

(b) Biological Systems: B E 468(3)*, BIOE 401(3), CH E 438(3), CHEM 202(3), MICRB 201(3)

(c) Natural Resource Systems: B E 467(3)*, B E 477(3), C E 370(3), C E 371(3), C E 461(3), C E 471(3)

(d) Food Process Systems: B E 465(3)*, CH E 446(3), FD SC 430(3), I E 312(3)

(e) Structural Systems: B E 462(3)*, A E 308(4), C E 340(3), C E 341(3), C E 342(3)

Last Revised by the Department: Summer Session 2009

Blue Sheet Item #: 37-05-031

Review Date: 2/24/09

UCA Revision #2: 7/26/07

EN

Bioengineering Minor

University Park, College of Engineering (BIOE)

PROFESSOR MARGARET SLATTERY *in charge*

This interdisciplinary minor is designed for students interested in the application of engineering principles to medical and biological problems. Prerequisites for the prescribed and supporting courses include PHYS 211 GN(4), PHYS 212 GN(4), and calculus through differential equations. Students interested in pursuing this minor should contact the Bioengineering program office.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES: (3 credits)

CHEM 112 GN(3) (Sem: 1-2)

ADDITIONAL COURSES (6 credits)

Select 3 credits of physiology from BIOL 141 GN(3) or BIOL 472(3) (Sem: 3-6)

*Select 3 credits of molecular/cell biology from B M B 251(3), BIOE 201(3), or BIOL 230W GN(4) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

*Select 6-9 credits of Bioengineering coursework from 3-credit courses at the 300, 400, or 500 level (Sem: 5-8)

*Select 0-3 credits of electives from Bioengineering-related courses (department list) or complete an Honors thesis on a bioengineering topic in any department (Sem: 5-8)

* At least 9 credits of bioengineering must be taken.

Last Revised by the Department: Spring Semester 2002

Blue Sheet Item #: 30-03-100

Review Date: 11/20/01

UCA Revision #1: 8/2/06

EN

Chemical Engineering Minor

University Park, College of Engineering (CH E)

PROFESSOR ANDREW L. ZYDNEY *Head of the Department of Chemical Engineering*

The job of the chemical engineer is to develop applications utilizing the most recent advances in the sciences, including chemistry, biology and materials science. The chemical engineering curriculum provides students with the knowledge and skill necessary to solve the problems of taking work from the small scale of the laboratory to actual implementation and construction.

While science disciplines emphasize the facts and principles of science, chemical engineering emphasizes its practical application on an industrial scale.

The chemical engineering curriculum covers such fundamentals as stoichiometry and materials balances, heat and mass transfer, thermodynamics, fluid dynamics, chemical equilibrium and reaction rates, economics, optimization, and control. The emphasis of the curriculum is placed on the utilization of these fundamental principles to analyze, design, construct, and operate processes in a diversity of fields, including the chemical, petroleum, food, polymer, pharmaceutical, electronic, and materials industries.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 21 credits

PRESCRIBED COURSES (21 credits)

CH E 210(3), CH E 220(3), CH E 320(3), CH E 330(3), CH E 350(3) (Sem: 3-6)

CH E 410(3), CH E 430(3) (Sem: 5-6)

Last Revised by the Department: Fall Semester 2005

Blue Sheet Item #: 33-04-175

Review Date: 1/18/05

EN

Engineering Entrepreneurship Minor

*Berks College
University Park, College of Engineering (ESHIP)*

PROFESSOR DHUSHY SATHIANATHAN*Interim Head, School of Engineering Design, Technology, and Professional Programs*

This interdisciplinary minor supports technology entrepreneurship development for all students, especially those majoring in engineering, business, and IST (Information Sciences and Technology). All segments of the U.S. and world economy are integrated with technology. The Engineering Entrepreneurship Minor addresses this new reality. Engineering graduates should have more business finance, marketing, and intellectual property knowledge, and business and IST students interested in technology enterprises should have a working knowledge of the engineering design process, basic engineering principles, graphics, and computer-aided design. All students should have solid skills in teamwork, leadership, and innovation in order to conceive, produce and promote creative product designs and solutions. Courses in the minor use problem-based learning, including business case studies and new product concept prototyping. Core courses include business plan presentations and competitions and open-ended design problems. The minor consists of 18 semester hours.

A grade of C or better is required in all classes used to meet the requirements of the minor. For admission to the minor, students must have completed ENGR 310(3) Entrepreneurial Leadership.

Scheduling Recommendation by Semester Standing given as (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (9 credits)

ENGR 310(3) (Sem: 4-6)

ENGR 407(3) (Sem: 5-7)

ENTR 430(3) (Sem: 6-8)

ADDITIONAL COURSES (3 credits)

Select one course from the list below:

ENGR 411(3) for non-business students (Sem: 5-7)

QMM 492(3) for non-engineering students (Sem: 5-7)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits from approved department list or in consultation with the coordinator of the Engineering Entrepreneurship Minor (Sem: 5-8)

Last Revised by the Department: Summer Session 2002

Blue Sheet Item #: 30-04-082

Review Date: 01/15/02

EN

Engineering Leadership Development Minor

University Park, College of Engineering (E L D)

PROFESSOR DHUSHY SATHIANATHAN*Interim Head, School of Engineering Design, Technology, and Professional Programs*

This interdisciplinary minor is designed to provide engineering students with critical principles and skills. Engineering graduates must demonstrate the ability to assume leadership roles in a competitive technologically complex global society. There are increasing demands for engineers to be able to deal effectively with other people, including the ability to work in teams and to interact with customers and other organizations on both national and international levels. Students will employ engineering case studies in active and collaborative classroom settings to develop these skills. The minor consists of 18 semester hours. A grade of C or better is required in all minor courses. Students in all engineering majors are eligible. For admission to the minor, students must have completed ENGR 408(2). Students should apply during their sophomore year.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (9 credits)

ENGR 409(3) (Sem: 5-6)

ENGR 408(2) (Sem: 5-8)

ENGR 493(1), S T S 460(3) (Sem: 7-8)

ADDITIONAL COURSE (3 credits)

B A 250(3) or ENGR 407(3) (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits in consultation with the coordinator of the Engineering Leadership Development Minor (Sem: 5-8)

Last Revised by the Department: Spring Semester 2002

Blue Sheet Item #: 30-03-100C

Review Date: 11/20/01

EN

Engineering Mechanics Minor

University Park, College of Engineering (E MCH)

PROFESSOR JUDITH A. TODD, *Head of the Department of Engineering Science and Mechanics*

The Engineering Mechanics Minor prepares students to analyze and/or design simple structures that are efficient and safe under foreseen loading conditions.

Contemporary engineering design of mechanical components requires precise information and modern analysis techniques to determine material response to anticipated loading. Designers must have the analytical and experimental tools to accurately define deformation under load to characterize dynamic response and to prevent mechanical failure. In the event of failure the cause(s) must be ascertained to prevent future failure through redesign and/or material substitution. Thus, industry has a real need for those with a sound foundation in Engineering Mechanics, the engineering science that deals with the effects of forces and torques on rigid and deformable bodies. Engineering Mechanics consists of Statics (bodies in equilibrium), Dynamics (bodies in unsteady motion such as vibration, moving on curvilinear paths) and the Mechanics of Deformable Media. The latter topic covers the change in dimensions of bodies of various shapes under the influence of forces, torques, temperature, and dynamic motion. Further failure criteria under such loadings are introduced and utilized in examples of engineering design. Some twenty undergraduate courses covering the above topics are available at two levels, i.e. sophomore introductory and senior (400) courses.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits**SUPPORTING COURSES AND RELATED AREAS:** (18 credits)

Select 12 credits of E MCH courses, which may include: E MCH 211(3), E MCH 212(3), E MCH 213(3), E MCH 315(2), E MCH 316(1) (Sem: 1-4)

Select 6 credits from 400-level E MCH courses (Sem: 5-8)

Last Revised by the Department: Fall Semester 2001

Review Date: 8/29/02

EN

Environmental Engineering Minor

University Park, College of Engineering (ENV E)

PROFESSOR BRIAN A. DEMPSEY, *in charge*

This minor is designed to provide students in engineering, science, and other majors with a comprehensive study of environmental issues and the skills necessary to solve problems associated with environmental pollution.

For entrance into the minor, students must be at least fifth-semester standing and have completed CHEM 110 GN(3), MATH 141 GQ(4), and PHYS 211 GN(4).

The minor consists of 18 credits, at least 6 of which must be at the 400 level. A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits (2 credits of engineering design are included)

PRESCRIBED COURSE (3 credits)

C E 370(3) (Sem: 3-6)

ADDITIONAL COURSES (15 credits)

Select 3 credits from: BIOL 230W GN(4), C E 479(1) and MICRB 400(2), CHEM 202(3), CHEM 210(3) (Sem: 3-8)

Select 3 credits from: B E 302(3), CH E 210(3), MN PR 301(3), NUC E 406(3), or NUC E 430(3) (Sem: 5-8)

Select 3 credits from: B E 467(4), AERSP 308(3), C E 371(3), CH E 302(5), M E 320(3), METEO 454(3), or NUC E 431W(4) (Sem: 5-8)

Select 6 credits (including at least 2 credits of engineering design) from: C E 472W(3), C E 475(3), C E 476(3), E R M 411(3), E R M 412(3), E R M 413W(3), EGEE 470(3), GEOSC 452(3), M E 405(3), M E 433(3), MN PR 427(3), MNG 444(2), MNG 445(3), NUC E 405(3), NUC E 420(3), NUC E 428(3), or P N G 405(3) (Sem: 5-8)

Last Revised by the Department: Summer Session 2002

Blue Sheet Item #: 30-04-082A

Review Date: 01/15/02

UCA Revision #1: 8/4/06

UCA Revision #2: 7/27/07

EN

Information Sciences and Technology for Aerospace Engineering Minor

University Park, College of Engineering

University Park, College of Information Sciences and Technology (ISASP)

The role of Information Sciences and Technology in the practice of Aerospace Engineering is very important. Aerospace systems rely heavily on computers, software, and digital information; for control, sensors, and other onboard systems. The Boeing 777 has more than 1000 processors and roughly 20 million lines of software onboard, and F-16 and F-117As cannot fly without their onboard computers. In addition, many future aerospace vehicles will be unmanned, and the software challenges will be even greater. The onboard memory has also increased exponentially, the F-106 had 20 KBytes of memory and the new Joint Strike Fighter might have 2 GBytes of memory. The hardware and software must be carefully designed and thoroughly tested, since most aerospace systems are mission- or safety-critical systems. Computers and software are heavily used in the design, development, and manufacturing of aerospace systems. Large supercomputers are often used in the design process. The IST minor will enrich their educational achievements and increase their chances in obtaining employment or entering graduate school. The NSF and the DOD are encouraging universities to enhance their educational programs so that we have well-qualified engineers for future systems, and our IPAC members have stressed the importance of IT for our students.

Student must apply for entrance to the minor no later than their 7th semester. A one-time tuition surcharge will be applied to all students enrolled in the minor.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 19 credits

PRESCRIBED COURSES (13 credits)

CMPSC 201C(3), IST 110 GS(3) (Sem: 1-4)

IST 210(4), IST 220(3) (Sem: 5-6)

ADDITIONAL COURSES (6 credits)

Select 6 credits from: AERSP 423(3), AERSP 424(3), AERSP 440(3), or AERSP 460(3) (Sem: 5-8)

Last Revised by the Department: Spring Semester 2008

Blue Sheet Item #: 36-01-038

Review Date: 8/28/07

UCA Revision #2: 7/26/07

[Comments\(http://www.psu.edu/bulletins/bluebook/contact \)](http://www.psu.edu/bulletins/bluebook/contact)

EN

Information Sciences and Technology for Industrial Engineering Minor

University Park, College of Engineering

University Park, College of Information Sciences and Technology (ISTIE)

Collection and processing of information have increased in all sectors for solving engineering problems, including manufacturing and service related problems. Efficient and timely analysis of data is critical for the survival of companies. There is a need for industrial engineers with a strong background in information technology and systems. The minor in Information Sciences and Technology for Industrial Engineering will augment the skills of students in the Department of Industrial and Manufacturing Engineering in the information systems area. All students pursuing a baccalaureate degree in Industrial Engineering are eligible for this minor.

A one-time tuition surcharge will be applied to all students enrolled in the minor.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 22 credits

PRESCRIBED COURSES (13 credits)

IST 110 GS(3) (Sem: 1-4)

I E 330(3), IST 210(4), IST 220(3) (Sem: 5-6)

ADDITIONAL COURSES: (9 credits)

Select 6-9 credits from I E 418(3), I E 462(3) and I E 433(3) (Sem: 7-8)

Select 0-3 credits from MATH 451(3), MATH 455(3), MATH 456(3), IST 441(3) (Sem: 7-8)

Last Revised by the Department: Spring Semester 2006

Blue Sheet Item #: 34-02-092

Review Date: 3/28/06

EN/IS

Nanotechnology Minor

University Park, College of Engineering (NANO)

PROFESSOR JUDITH A. TODD, Head of the Department of Engineering Science and Mechanics

The Nanotechnology minor is designed to help prepare students from diverse disciplines for careers in a broad range of industries innovating with nanotechnology. The minor builds on the singular strengths of Penn State's nanofabrication facilities including its class 1 and class 10 clean rooms, its faculty, and existing academic programs. The minor provides students with fundamental knowledge and skills in simulation, design, modeling, syntheses, characterization, properties, processing, manufacturing, and applications at the nano scale.

As nanotechnology increasingly bridges across disciplines, a basic understanding of mathematics, physics, biology, and chemistry is recommended. To complete the 18 credit nanotechnology minor, students will take two prescribed courses (6 credits) in nanoscience fundamentals, and then select four additional courses (12 credits) from a growing list of courses that address the areas described in the previous paragraph. A grade of C or better is required for all courses in the minor.

In addition to nanotechnology career opportunities in microelectronics, information storage, optoelectronics, bioelectronics, pharmaceuticals, agriculture, medicine, life sciences and the sciences, the minor prepares undergraduate students to support major new nanotechnology research programs as graduate students. Interested 3rd and 4th year students from related fields in engineering, the chemical, physical, and the biological sciences, medicine, life, and agricultural sciences are encouraged to enroll.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES: (6 credits)

E SC 312(3), E SC 313(3) (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS: (12 credits)

Select 12 credits from an approved list, at least 6 credits must be at the 400 level. (Sem: 5-8)

Last Revised by the Department: Summer Session 2006

Blue Sheet Item #: 34-04-029

Review Date: 1/17/06

EN

Peace and Conflict Studies Minor

University Park, College of Engineering (PEACE)

PROFESSOR MARTIN PIETRUCHA, *Director, Science, Technology, and Society Program*

This minor may be pursued by students in any major. It is designed to help students take a coherent set of courses organized around the study of the sources of international conflict, peace movements, and peace building. The minor requires 18 credits, of which at least 9 must be upper division, including 6 credits at the 400 level. Students will be required to take two prescribed courses in Science, Technology, and Society, one introductory and one capstone. They also will take 6 credits of additional courses with an international focus and 6 credits from a list of supporting courses, which includes the study of conflict in race relations, family, community, and the development of personal peace as a precursor to peace building. The full requirements with the lists of additional and supporting courses are available in the Science, Technology, and Society program office, 133 Willard Building, University Park Campus. Substitutions for requirements, such as that necessary for Political Science majors taking an alternative to PL SC 014 GS;IL(3), require the permission of the Peace and Conflict Studies minor adviser or the director of the Science, Technology, and Society program.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (6 credits)

S T S 090(3) (Sem: 1-4)

S T S 490(3) (Sem: 7-8)

ADDITIONAL COURSES (3 credits)

INT U 200 GS(3) or PL SC 014 GS;IL(3) (Sem: 3-8)

(INT U 200 GS(3) and PL SC 014 GS;IL(3) cannot both be taken for credit)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 3 credits from the additional course list in the S T S program office (Sem: 3-8)

Select 6 credits from the supporting course list in the S T S program office (Sem: 3-8)

Last Revised by the Department: Spring Semester 1995

Blue Sheet Item #: 22-06-013

Review Date: 1/30/00

EN

Product Realization Minor

University Park, College of Engineering (PRODR)

PROFESSOR TIMOTHY W. SIMPSON, *in charge*

This 21 credit interdisciplinary minor is designed for any engineering student who is interested in state-of-the-art practice in integrated product/process design and manufacturing. The program culminates with a one-semester project involving the design and manufacture of a new product.

The purpose of the minor is to offer students state-of-the-art practice in integrated product/process design and manufacturing. Students completing the minor should:

understand the interaction of design and manufacturing through practical examples;

be familiar with the entrepreneurial skills needed to transfer a new product from initial idea to market;

understand the technical and management aspects of concurrent engineering and total quality management; and

have hands-on experience in designing and manufacturing a product, organizing and managing the effort, and interacting with the customer.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 21 credits

PRESCRIBED COURSES (9 credits)

M E 240(3) (Sem: 1-4)

ENGR 407(3) (Sem: 5-6)

I E 466(3) (Sem: 5-8)

ADDITIONAL COURSES (12 credits)

Select 9 credits in Product Design, Quality Engineering, and Manufacturing Processes courses approved by the professor in charge of the minor (Dr. Simpson). Example courses include: E E 310, E E 441, I E 305, I E 306, I E 310, I E 311, I E 312, I E 424, I E 428, I E 464, M E 340, M E 445 (Sem: 5-8)

Select a 3-credit senior project: team-based design or industrial projects course, as approved by the coordinator (Sem: 7-8)

Last Revised by the Department: Summer Session 2007

Blue Sheet Item #: 35-01-138

Review Date: 8/29/06

UCA Revision #2: 7/30/07

EN

Six Sigma Minor

University Park, College of Engineering (SIGMA)

PROFESSOR RICHARD KOUBEK, Head, Harold and Inge Marcus Department of Industrial and Manufacturing Engineering

Six Sigma has been increasingly internalized by companies involved in manufacturing, health care, and service industries. The Six Sigma process has also been used to address environmental concerns such as water quality and energy conservation. Thus, this minor is designed for students who are interested in the Six Sigma statistical methodology for increasing productivity and enhancing quality. The minor will provide students with an understanding of how business models are changing in response to globalization and how the Six Sigma process and product improvement methodology is thus a vehicle for industry prosperity in this climate. Students completing the minor will develop their analytical and statistical skills, and gain a competitive advantage in the work place.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (18 credits)

I E 305 (3), I E 322 (3), I E 323 (3) (Sem: 5-6)

I E 433 (3), I E 434 (3), I E 436 (3) (Sem: 7-8)

Last Revised by the Department: Summer Session 2009

Blue Sheet Item #: 37-06-042

Review Date: 4/14/09

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The University reserves the right to change the requirements and regulations listed here and to determine whether a student has satisfactorily met its requirements for admission or graduation, and to reject any applicant for any reason the University determines to be material to the applicant's qualifications to pursue higher education. Nothing in this material should be considered a guarantee that completion of a program and graduation from the University will result in employment.

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