

# **UNDERGRADUATE MANUAL CIVIL ENGINEERING**

*DEPARTMENT OF CIVIL, STRUCTURAL AND  
ENVIRONMENTAL ENGINEERING*

**School of Engineering and Applied Sciences**



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# 1. INTRODUCTION

## 1.1 PURPOSE OF THIS MANUAL

This manual has been designed as a general reference for enrolled undergraduate civil engineering majors. An online version can be read or downloaded [here](#). Users of this manual should check the web site periodically for published errata. Students intending to pursue the BS environmental engineering degree should consult the *Environmental Engineering Undergraduate Manual*.

The guidance presented in this manual is based on the policies and procedures of the University at Buffalo (UB), the School of Engineering and Applied Sciences (SEAS), and the Department of Civil, Structural and Environmental Engineering (CSEE) as of September 1, 2007. The University reserves the right to modify the procedure and requirements outlined in this manual. Such modifications generally will not be considered as retroactive.

You must follow the procedures in place when you entered the major. Official UB policies are found in the [Undergraduate Catalog](#). Additional information may be found at the website of the [Office of Undergraduate Education](#) in SEAS (410 Bonner Hall). UB rules and regulations regarding student rights and responsibilities may be found at the website of the [Office of Judicial Affairs & Student Affairs](#).

In accordance with federal and state laws, no person in whatever relationship with the University at Buffalo shall be subject to discrimination on the basis of age, religion or creed, color, disability, national origin, race, ethnicity, sex or sexual orientation, or marital or veteran status.

## 1.2 OVERVIEW OF CIVIL ENGINEERING

Civil engineering involves the exploration, research, planning, analysis, design, construction, and operation of facilities essential to modern life. Civil engineering systems include highways, bridges, tunnels, airports, and aerospace structures, railways, pipelines, dams, irrigation systems, towers, buildings for commerce and industry, water supply and distribution networks, and waste management facilities.

Key features of civil engineering projects are summarized below:

- Each civil engineering project is unique, constructed as a single entity (unlike manufactured items such as cars and computers). Each civil engineering project receives individual planning, investigation, design, and performance monitoring.
- Civil engineering projects frequently involve simultaneous consideration of technical, governmental, legal, financial, and social elements. Civil engineers require broad technical training as well as strong communication skills.
- In addition to traditional scientific tools, civil engineering projects rely on modern computing and information technologies such as computer-aided design (CAD), remote sensing and data acquisition, Geographic Information Systems (GIS), and massively-parallel computing.

Civil engineering can be divided into several subdisciplines:

- **Construction management engineers** supervise the construction and maintenance of facilities that provide fundamental support for our modern societies, including but not limited to roads, bridges, water and sewer lines, power plants, and dams.
- **Environmental engineers** address diverse problems such as drinking water supply, air pollution control, carbon management and global warming, energy, hazardous waste management, storm water and wastewater management, solid waste disposal, public health, and ecosystem management.
- **Geotechnical engineers** design foundations, ground improvement, slopes and embankments, retaining walls, dams, landfills, shoring, underpinning of structures, below-ground waste containment, soil clean-up, landfills, and wetland drainage systems.
- **Structural engineers** design and analyze different types of structural systems, including but not limited to buildings, bridges, pipelines, machinery, automobiles, and spacecraft.
- **Transportation Engineers** focus on the planning, design, construction, and management of highway systems, pavement materials, airports, rapid transit systems, and computer control of traffic signals.

Graduates of UB's civil engineering program have found employment:

- *In private practice (consulting or industry), participating in the research, planning, design, construction, and maintenance of public and commercial facilities and structures.*
- *In public practice (city, county, or state agencies), participating in city/regional planning and the design and construction of highways, pipelines, and other public works.*
- *At colleges and universities, training future civil engineers and conducting research to develop new and improved technologies.*
- *In multidisciplinary settings, combining civil engineering training with geology, economics, law, software engineering, architecture, and information technology.*

Typical annual starting salaries for civil engineers with a BS degree are in the \$45,000 to \$55,000 range. Factors influencing salary include educational level, experience, specialization, grade point average, and computer skills. A growing number of employers require graduate degrees for entry-level engineering jobs.

More detailed descriptions of the civil engineering subdisciplines are included in *Specialization Tracks*.

## 1.3 CIVIL ENGINEERING AT UB

### THE DEPARTMENT

The Department of Civil, Structural and Environmental Engineering offers the only degree in civil engineering within the State University of New York system. With 25 full-time faculty members, the Department has yearly research expenditures in the range of \$10 to \$15 million, and is the home of three major research centers. The integration of research with undergraduate teaching provides students with unique opportunities for state-of-the-science training.

The goals of the Department are expressed in its *Vision* and *Mission* statements:

## **VISION STATEMENT**

*Our vision is to be recognized as a prominent department in civil engineering in the United States and a premier department in civil engineering among public universities in the northeastern United States. Our vision is guided by principles of stability and flexibility. We will maintain our strength in the traditional areas of civil engineering, but we will be flexible and we will face the new challenges in our professional environment. We foresee the need for a continual reassessment and change of our teaching and research focus as we respond to the following trends: (a) advancements in technology, (b) multidisciplinary approach, (c) responsibility to society, and (d) accountability and efficiency.*

## **MISSION STATEMENT**

*Civil, structural and environmental engineers contribute to the health, safety, and quality of life of society through the design, construction, and operation of public and private infrastructure. The mission of the Department of Civil, Structural and Environmental Engineering is to:*

- *Educate students in fundamental concepts, critical thinking, technical skills and ethical principles as applied to engineering analysis and design,*
- *Serve the engineering profession and society through scholarship and innovative research, and*
- *Provide the local, national, and international communities with continuing educational opportunities, technical assistance, and intellectual resources.*

## **THE CURRICULUM**

UB's civil engineering program provides you with an integrated education in mathematics, basic sciences, English composition, ethics, humanities, and fundamentals of civil engineering, engineering design, and computer simulations in engineering. A solid foundation is provided in four major discipline areas of civil engineering, with more in-depth specialization provided through a choice of senior-year electives. While pursuing your BS degree, you also can gain valuable industrial experience through co-op and internship programs. The department encourages civil engineering students who are also interested in other areas of study to consider the options of double-degree or double-major programs, as described in Section 3.

UB graduates with a BS degree in civil engineering find employment with private consulting firms, with industry, and with government agencies. Many return immediately or within a few years to graduate school for advanced studies leading to a Master of Engineering (ME), Master of Science (MS) or Doctor of Philosophy (PhD) degree. Graduates of the program have the skills and most of the prerequisites to pursue further education in law, medicine, management, and other professional fields.

## **THE FACULTY**

Instruction in the Department of Civil, Structural and Environmental Engineering is provided by 25 distinguished full-time faculty and approximately 10 adjunct faculty. All full-time faculty hold doctoral degrees, and many have earned national awards, including (among the current faculty): the *SUNY Chancellor's Awards for Excellence in Teaching* (3 recipients), the *National Science Foundation Presidential Young Investigator Award/Career Award* (4 recipients), the *Office of Naval Research Young Investigator Award*, the *SUNY Chancellor's Award for Excellence in Scholarship and Creative Activity*, the *SUNY Distinguished Professor* (2 at this rank), and the *New York State Society of Professional Engineers Engineering Educator of the Year Award*.

## **THE RESEARCH INFRASTRUCTURE**

The Department of Civil, Structural and Environmental Engineering has active research programs in the areas of structural and earthquake engineering, environmental engineering, computational mechanics,

and geotechnical engineering. These research programs include several nationally recognized multidisciplinary centers:

- [MCEER](#) is a national center of excellence dedicated to the discovery and development of new knowledge, tools and technologies that equip communities to become more disaster resilient in the face of earthquakes and other extreme events. MCEER accomplishes this through a system of multidisciplinary, multi-hazard research, education and outreach initiatives. Established in 1986 by the National Science Foundation (NSF), it was the country's first national center for earthquake engineering research.
- [The Center for Integrated Waste Management](#) (CIWM) was established at the University at Buffalo by New York State in 1987 to initiate and coordinate research and development in the area of toxic substances and hazardous wastes. The Center currently promotes the development and application of improved environmental technologies and management methods for 1) more effectively remediating past environmental contamination and promoting redevelopment of formerly contaminated properties, and 2) preventing, reducing, reusing, and recycling industrial and municipal waste streams. The Center provides assistance to communities, industries, businesses, public agencies, and non-profit organizations.
- [The Great Lakes Program](#) was established in 1985 to support efforts designed to protect and preserve the Great Lakes Ecosystem. This ecologically and economically important ecosystem is home to more than 40 million people in the United States and Canada. The mission of the Great Lakes Program is to coordinate the development, evaluation, and synthesis of scientific and technical knowledge on the Great Lakes Ecosystem in support of public education and policy formation.

In addition to the above UB Centers that are based the Department, civil engineering students and faculty participate in the activities of several other research centers, including the *Center for Computational Research*, the *Electronics Packaging Laboratory*, the *National Center for Geographic Information and Analysis*, and the *Environment and Society Institute*.

## STUDENT ORGANIZATIONS

The main student organization that civil engineers participate in is the American Society of Civil Engineers (ASCE) student chapter. The student chapter of ASCE contains the Concrete Canoe and Steel Bridge Teams. Civil engineering students are afforded the opportunity to participate in many nationally-recognized professional organizations, including:

- Air and Waste Management Association (AWMA)
- Associated General Contractors of America (AGC)
- Chi Epsilon, Civil Engineering Honor Society
- Earthquake Engineering Research Institute (EERI)
- Engineers for a Sustainable World (ESW)
- National Society of Professional Engineers (NSPE)
- National Society of Black Engineers (NSBE)
- New York Water Environment Association (NYWEA)
- Society of Women Engineers (SWE)
- Society of Hispanic Professional Engineers (SHPE)
- Tau Beta Pi, Engineering Honor Society
- UB Environment Engineering and Science Club (UBEESC)

## PROFESSIONAL REGISTRATION

The UB civil engineering program is designed to support eventual licensure as a Professional Engineer (PE). It is strongly recommended that all students consider professional registration as part of their career path.

Obtaining registration as a PE is a multi-step process that normally includes graduation with a BS degree from an ABET-accredited program. If you are within 20 credits of graduation, then you are eligible to take the Fundamentals of Engineering (FE) exam. Students graduating in May generally take the FE exam in April.

After graduation, the new engineer must accumulate a specified period of experience (usually 4 years) working under the supervision of a licensed PE. The final requirement for registration is the successful completion of the PE exam, which is administered on a state-by-state basis. In most states, completion of a Master's degree will reduce the required experience (e.g., from 4 to 3 years). More information about professional licensure is available from the [American Society of Civil Engineers](#), the [National Council of Engineering Examiners](#), and the [New York State Department of Education](#).

Although the FE exam can be taken at any point prior to applying for the PE license, most full-time UB engineering students take the exam in April of their senior year. (The test is also offered in October.) The registration deadlines for the April and October exams are normally in the preceding November and May, respectively. Exam dates for the next ten years may be found [here](#). April exams are typically offered in Rochester NY, while the October exams are given in Buffalo.

To assist with preparation for the FE exam, an evening review class is offered each year at UB by the Engineering Society of Buffalo. The course typically involves a weekly 3-hour review session for 23 weeks. Full-time UB students normally receive a 50 percent discount on the standard course fee.

For more information about the FE exam, contact the Director of Undergraduate Studies or visit the [information page](#) maintained by the SEAS Office of Undergraduate Education.

## 2.1 PROGRESS TOWARDS GRADUATION

### 2.1 ADVISEMENT

You have a variety of resources for academic advisement. As you progress through the academic program, each member of your advisement team will play a different role, depending on your status and needs. Key advisement personnel are reviewed below and summarized in Table 1.

#### KEY ADVISEMENT PERSONNEL (SEE APPENDIX B FOR CONTACT INFORMATION)

##### *Freshman Mentor*

Engineering students entering UB as freshman are assigned a faculty mentor whose responsibility is to meet with the student on a voluntary basis during the freshman year. The primary role of the mentor is to provide general guidance and encouragement during the transition to college-level study, as well as information on engineering careers. In general, the mentor is not expected to provide specific advice regarding degree requirements. These functions are performed by other members of the advisement team. In the Department of Civil, Structural and Environmental Engineering, your freshman mentor normally continues as your faculty advisor.

##### *Student Excellence Program Staff*

The SEAS Office of Undergraduate Education operates a program called the Student Excellence Initiative. It is designed to assist students in developing good study habits and making an effective transition to engineering study at the University level. A number of voluntary programs are available, including group study session and tutoring in science, math, and basic engineering courses. Details are available [here](#).

##### *Departmental Faculty Advisor*

When you enrolled as a civil engineering major, you were assigned an academic advisor who is a full-time member of the CSEE faculty (hereafter, your faculty advisor). A current list of faculty advisors is posted on the Departmental [website](#). If your name is not on the list, please contact the Undergraduate Studies Secretary to request the assignment of a faculty advisor. You may request a change in your assigned Departmental advisor at any time by contacting the Undergraduate Studies Secretary.

The role of the faculty advisor is to provide general guidance regarding the civil engineering curriculum and career paths. Specific questions regarding nonstandard issues such as transfer credits, general education, and course substitutions will normally be directed to other appropriate members of the advisement team (see Table 1). Juniors and seniors are required to meet with their faculty advisor once each semester during the registration period. This is accomplished through forced-registration in CIE 340, CIE 439, and CIE 415.

##### *Director of Undergraduate Studies*

The CSEE Director of Undergraduate Studies is a faculty member who performs a variety of functions, including, but not limited to approval of upper level course transfers or substitutions, assistance to students with academic or registration problems, advisement of students in combined degree programs, and coordination of ABET accreditation activities. The Director of Undergraduate Studies also approves waivers for MAE 177. Students may request a meeting with the Director of Undergraduate Studies at any time.

### ***Undergraduate Studies Secretary***

The Undergraduate Studies secretary assists students with a variety of issues, including advisor assignments, forms, and forced registration.

### ***SEAS Office of Undergraduate Education academic advisors***

An academic advisor from the SEAS Office of Undergraduate Education (hereafter, an engineering advisor) is often the first student contact, usually as part of the orientation process. Meetings with an engineering advisor are generally recommended on a semester basis for the first two years and on an as-needed basis thereafter, usually upon student request.

In addition to providing general academic advice, the engineering advisors make decisions regarding transfer credit for basic math, science, and general engineering (EAS) courses, provide information on General Education requirements, and provide a final review to ensure that the student has met all degree requirements at the time of graduation. As you progress through your program of study, individual advisement is increasingly provided by the civil engineering faculty advisor.

**Table 1. Advisement Guide (see Appendix B for contact information)**

<b>If You Need Help With:</b>	<b>Contact</b>
Elective choices, career opportunities	Faculty advisor
General education, transfer credits, DARS errors, degree audit	Engineering advisor
Academic integrity issues	Course instructor, Department Chair
<a href="#">Advisor list</a> , forms, flowsheets, forced registration	Undergraduate Studies Secretary
MAE 177 exceptions, any other issues	Director of Undergraduate Studies

## **ADVISEMENT DOCUMENTS AND RESOURCES**

### ***Flowsheet***

The Department maintains a flowsheet for tracking progress toward degree requirements for each student (see Appendix 1). (Official flowsheets are maintained by the SEAS Office of Undergraduate Education.) The flowsheet is updated on a semester basis and is referenced extensively by both the faculty and engineering advisors. A copy of your flowsheet may be obtained from the Undergraduate Studies Secretary.

### ***DARS Reports***

The Degree Audit Reporting System (DARS) Report is another guidance document to assist you on your path to graduation. Although unofficial, it provides useful information about unfulfilled graduation requirements. Students are encouraged to use DARS only for preliminary screening; any discrepancies should be brought to the attention of the Director of Undergraduate Studies and/or the engineering advisor.

### ***TAURUS***

In general, acceptance of transfer credits is determined by the SEAS Office of Undergraduate Education in consultation with the Director of Undergraduate Studies. However, for colleges and universities within the SUNY system and other selected institutions, a large number of courses have been prescreened to

establish articulation (equivalence) with UB courses. A searchable version of the articulation database (called [TAURUS](#)) is available.

## KEY ADVISEMENT EVENTS

### *Initial advisement: freshman and new transferees*

During the initial SEAS orientation, your educational background and prospective major were reviewed by an engineering advisor, and your registration into the appropriate classes for the first semester was processed. Where applicable, transfer and high school Advanced Placement (AP) credits were reviewed and recorded on your flowsheet. (Transfer students and freshmen requesting AP credit should forward their final transcript to the UB Admissions Office well in advance of the initial orientation.)

### *Meeting with mentor: freshmen and sophomores*

During the orientation period (usually the day before classes start in the fall), freshmen are provided with an opportunity to meet with their freshman mentor. During the semester, meetings may be initiated by the student or the mentor. Faculty mentors are encouraged to ensure that at least three meetings take place during the fall semester. The frequency of subsequent meetings depends primarily on the student's interest and availability.

### *Meeting with CSEE faculty advisor: all students*

You should meet with your faculty advisor at least once each semester prior to the start of registration for the following semester. In conjunction with the advisement meeting, juniors and seniors must complete an *Advisement Form* with the help of their faculty advisor, and submit a signed copy of the completed form to the Undergraduate Studies Secretary.

The purpose of the advisement meetings is to help you choose the best available courses in proper sequence, and to facilitate completion of the degree program within the desired length of time and with your best performance. Without proper advisement, you can make mistakes in selecting courses that can delay graduation. Consultation with faculty advisors can help minimize the possibility of such errors. **Nevertheless, it is ultimately your responsibility to see that all degree requirements are met in time to enable graduation at the desired date.**

You may request a meeting with your CSEE faculty advisor at any time to obtain general academic and professional advice.

### *Degree audit: optional for seniors*

After you have filed the required UB *Application for Degree* form (see Section 2.3), formal review of the academic records is performed by the SEAS Office of Undergraduate Education to verify that all graduation requirements have been met. At any point in time (typically during the semester preceding the anticipated final semester), you may request an informal degree audit from the Office of Undergraduate Education staff to verify that graduation requirements are being addressed in a timely fashion. This action is recommended for transfer students and/or students who have multiple approved course substitutions. An informal degree audit is probably not necessary if you entered UB as a freshman, have followed the recommended curriculum consistent with this manual, and have met regularly with your faculty advisor.

### *General advisement meetings*

At regular intervals, general advisement meetings will be held to address special topics (e.g., combined-degree programs, work experience courses, professional registration, etc.). These meetings will be publicized via class announcements, flyers, and e-mail listservs.

## **2.2 CAREER DEVELOPMENT CURRICULUM**

To assist you with your progress towards a job or graduate school after graduation, the SEAS faculty has created a career development curriculum. The curriculum comprises a series of milestones for each semester and summer during your academic career. The career development curriculum may be found [here](#). The key part of the career development curriculum is the [career development curriculum chart](#). Each semester, a faculty member or representative from Career Services will remind you of the milestones for that semester.

## **2.3 REGISTRATION**

You can register for courses through [MyUB](#) (a web-based personal portal to online UB resources) during the appropriate periods indicated in the UB registration schedule. Several of the junior and senior courses require forced registration (see Section 2.1). To complete the registration process in junior/senior semesters, you should: 1) download the advisement form, 2) schedule an appointment with your faculty advisor to discuss course selection and obtain the necessary signature (list of advisors is [here](#)), 3) register for all non-force courses through MyUB, 4) submit a copy of a signed advisement form to the Undergraduate Studies Secretary (see contact list in Appendix B), and 5) check MyUB periodically to verify that preregistration, including the required forced registration, has been completed. **It is your responsibility to ensure that all course registration activities are completed in a timely fashion.** If you experience difficulty with any aspect of the registration process, contact the Director of Undergraduate Studies.

It should be noted that **pre- and co-requisite requirements, especially in the Department and SEAS, are strictly enforced.** Consult the University Catalog for pre- and co-requisite requirements.

Under some circumstances, juniors and seniors may select a graduate course as a Technical Elective. Good academic standing and permissions from the instructor and the Director of Undergraduate Studies are required. Forced registration will be accomplished by the Undergraduate Studies Secretary upon submittal of the advisement form with signatures from the instructor and Department Chair.

## **2.4 GRADUATION**

The Bachelor of Science degree in civil engineering is awarded upon successful completion of the required courses (summarized in Section 3) with grade-point averages (GPAs) of 2.0 or higher in two categories: *overall* (all UB courses) and *engineering* (EAS, CIE, and other courses offered in SEAS).

### *Application for Degree*

To be considered for graduation (degree conferral), you must file an *Application for Degree Card* with the Student Response Center prior to deadlines published in the Undergraduate Catalog (February 1 for

June 1 graduation, July 1 for September 1 graduation, and October 1 for February 1 graduation). **It is your responsibility to ensure compliance with this requirement, which is strictly enforced.**

## **2.5 ACADEMIC GOOD STANDING**

You will be placed on UB Engineering academic probation if your cumulative technical GPA or cumulative engineering GPA is less than 2.0, *or* if your most recent semester technical GPA or engineering GPA is less than 2.0. (The technical GPA includes all science, math, and engineering courses.) Further details can be found [here](#).

## 3. CURRICULUM

### 3.1 OVERVIEW

The current civil engineering curriculum is summarized in Table 2. (Students who entered as freshman prior to Fall 2000 or transferred prior to Fall 2002, may have slightly different requirements and should consult the Director of Undergraduate Studies.)

During the first two years of study, the civil engineering curriculum provides for the development of knowledge and skills in the sciences, mathematics, and English composition and reading. In the junior year, this development is supplemented and followed by a number of basic engineering and civil engineering courses. As a result, when you enter your senior year, you are prepared to pursue specialization interest in any one of the four specialization tracks of civil engineering, or pursue a general civil engineering program.

Students with interests that extend outside of civil engineering should investigate the various dual and combined-degree offerings described in Section 4. Students may also pursue “customized” double majors and minors, subject to the guidelines given in the UB Undergraduate Catalog (for more details, contact the Director of Undergraduate Studies). For example, a math minor is popular among civil engineering students.

### 3.2 GENERAL EDUCATION

All UB students must take a specified number of General Education courses. Several sets of requirements are potentially applicable depending on when (i.e., what year) and how (i.e., transfer or freshman) you entered UB. These requirements are summarized [here](#).

### 3.3 TECHNICAL ELECTIVES

Fifteen credits of upper-division Technical Electives (usually five courses) are required for the BS civil engineering program. Many students select Technical Electives to provide specialization in one of the civil engineering subdisciplines (see Section 3.4). However, any combination of approved Technical Electives (see Table 2) may be selected, subject to the following constraints:

- At least one course must be selected from the design electives CIE 428, CIE 429, CIE 430, CIE 438, CIE 442, or CIE 449.
- Only three credits of the work-experience courses (CIE 404, CIE 406-408, EAS 396, and EAS 496) may be counted as a Technical Elective.
- In some cases, graduate courses or senior-level courses from outside of civil engineering may be taken as Technical Electives with *prior written approval* from the Director of Undergraduate Studies.

**TABLE 2. BS CIVIL ENGINEERING CURRICULUM**

<b>FIRST YEAR</b>			
<b>FALL</b>		<b>SPRING</b>	
MTH 141 Calculus I	4	MTH 142 Calculus II	4
CHE 107 Chemistry I	4	PHY 107 Physics I	4
EAS 140 Engineering Solutions	3	CHE 108 Chemistry II	4
General Education	3	MAE 177 Intro. Eng. Dwg./CAD	2
ENG 101 Writing 1 or ENG 102 Writing 2 <sup>1</sup>	3	ENG 201 Reading and Adv. Writing or General Ed. <sup>1</sup>	3
CIE 101 Great Creations of Civil Eng.	1	Library Skills Workbook	
<b>TOTAL:</b>	<b>18</b>	<b>TOTAL:</b>	<b>17</b>

<b>SECOND YEAR</b>			
<b>FALL</b>		<b>SPRING</b>	
MTH 241 Calculus III	4	MTH 306 Differential Equations	4
PHY 108 <i>and</i> PHY 158 Physics II	4	EAS 208 Dynamics	3
EAS 207 Statics	3	EAS 209 Mechanics of Solids	3
EAS 230 Higher-Level Language <sup>2</sup>	3	General Education	3
General Education	3	Engineering Elective (see note 5)	3
<b>TOTAL:</b>	<b>17</b>	<b>TOTAL:</b>	<b>16</b>

<b>THIRD YEAR</b>			
<b>FALL</b>		<b>SPRING</b>	
CIE 323 Structural Engineering I	3	CIE 324 Structural Engineering II	3
CIE 354 Fluid Mechanics	3	CIE 334 Mechanics of Soils	3
CIE 327 Civil Engineering Materials	3	CIE 340 Environmental Engineering	3
CIE 303 Geodesy, GPS, GIS	3	CIE 343 Hydraulic Engineering	3
CIE 308 Engineering Statistics	3	General Education	3
CIE 361 Civil Engineering Laboratory I	2	CIE 362 Civil Engineering Laboratory II	2
<b>TOTAL:</b>	<b>17</b>	<b>TOTAL:</b>	<b>17</b>

<b>FOURTH YEAR</b>			
<b>FALL</b>		<b>SPRING</b>	
CIE 439 Transportation System Analysis	3	CIE 415 Professional Practice Issues	3
CIE 435 Foundation Engineering	3	Technical Elective <sup>3</sup>	3
Technical Elective <sup>3</sup>	3	Technical Elective <sup>3</sup>	3
Technical Elective <sup>3</sup>	3	Technical Elective <sup>3</sup>	3
Applied Math Elective <sup>4</sup>	3	General Education	3
<b>TOTAL:</b>	<b>15</b>	<b>TOTAL:</b>	<b>15</b>

**SUMMARY:**

Required Civil Engineering Courses	= 41 credit hours
Required Basic Science and Math Courses	= 32 credit hours
Required Eng. Science Courses (includes Applied Math Elective)	= 23 credit hours
Technical Electives	= 15 credit hours
General Education Courses <sup>1</sup>	= 18-21 credit hours
<b>TOTAL</b>	<b>= 129-132 credit hours</b>

**NOTES:**

1. Includes 3-6 credit hours of Writing Skill Requirement: ENG101 and ENG201 (or ENG102, contingent upon SAT or ACT score)
2. Or CSE 113: take CSE 113 if you want to take CSE 114 as an engineering elective
3. At least one of the Technical Electives must be selected from CIE 428, CIE 429, CIE 430, CIE 438, CIE 442, or CIE 449
4. Applied Math Elective: Select one from: MTH 309 Linear Algebra, MAE 376 Numerical Methods, MTH 417 Multivariable Calculus, or MTH 418 Analytical Methods (or MAE 428),
5. Engineering Elective: Select one from: EE 200 Circuits, MAE 204 Thermodynamics, IE 320 Engineering Economy, or CSE 114 Computer Science II (CSE 114 requires CSE 113 as a prerequisite)

**TABLE 3. APPROVED TECHNICAL ELECTIVES**

<b>Course<sup>1</sup></b>	<b>Prerequisite</b>
CIE 404 Civil Engineering Internship <sup>2</sup> (F,S)	Good Senior Standing
CIE 406-408 Civil Engineering Co-op <sup>2</sup> I, II, III (F, S, Su)	Good Junior Standing
CIE 423 Structural Engineering III (S)	CIE 324
CIE 424 Computer-Aided Design in Civil Engineering (S)	MAE 177, Senior Standing
CIE 426 Finite Element Structural Analysis (F)	Good Senior Standing
CIE 428 Steel Design (F)	CIE 324
CIE 429 Reinforced Concrete Design (F)	CIE 324
CIE 430 Wood Design	CIE 324
CIE 437 Pavement Design and Materials (S)	CIE 334
CIE 438 Structural Design and Construction of Foundations (S)	CIE 435
CIE 441 Ecological Engineering (F)	MTH 306
CIE 442 Treatment Process Engineering (S)	MTH 306
CIE 444 Hydrologic Engineering (F)	CIE 343, CIE 308
CIE 445 Groundwater Engineering (S)	Good Senior Standing
CIE 447 Environmental Engineering Practicum (F)	Good Senior Standing
CIE 448 Chemical Principles of Environmental Engineering (F)	CIE 340
CIE 449 Environmental Engineering Design (S)	Good Senior Standing
CIE 458 Introduction to Geoenvironmental Engineering (F)	CIE 334
CIE 469 Hazardous Waste Management (F)	Good Senior Standing
CIE 476 Design and Construction of Earth Structures (S)	CIE 334
CIE 491 Construction Estimating (F)	Good Senior Standing
CIE 493 Project Management (S)	Good Senior Standing
EAS 480 Technical Communications (F, S)	Permission of Instructor
EAS 396 Engineering Career Institute <sup>2</sup> (Sp)	Good Senior Standing
EAS 496 Engineering Co-op <sup>2</sup> (Su)	Good Senior Standing

**NOTES:**

1. Usual semester offered: F = Fall, S = Spring, Su = summer
2. Only three credits of Technical Elective may be satisfied by work-experience courses (CIE 404, EAS 396, EAS 496, or CIE406-408).

The flexibility in Technical Electives provides students with an opportunity to specialize in one of the civil engineering subdisciplines (see Section 3.4). Recommended Technical Electives include the following:

- Structural Engineering: CIE 423 or CIE 430, CIE 428, CIE 429, plus two others
- Geotechnical Engineering: CIE 438, CIE 458, CIE 476, plus two others
- Environmental Engineering: CIE 441, CIE 442, CIE 449, plus two others
- Construction Management Engineering: CIE 429, CIE 491, CIE 493, plus two others

### **3.4 SPECIALIZATION TRACKS**

The flexibility in Technical Electives provides you with an opportunity to specialize in one of the civil engineering subdisciplines. You may pursue a general degree program or configure your electives to provide specialization in one of four subdisciplines, as detailed in the subsequent sections.

#### **CONSTRUCTION MANAGEMENT ENGINEERING**

Construction engineers are responsible for constructing and maintaining facilities that provide fundamental support for our modern societies, including, but not limited to, roads, bridges, water and sewer lines, power plants, and dams. These projects require an extensive knowledge and understanding of engineering and management fundamentals, as well as the use of computers and new technologies for the management of time, money, people and materials and equipment. Construction engineers also address the specific concerns of improvement of safety and occupational health.

The Department of Civil, Structural and Environmental Engineering offers a broad-based education in civil engineering designed to equip students for a variety of career opportunities. As part of the required civil engineering curriculum, all students take the following courses related to construction management engineering:

- CIE 303 Geodesy/GIS/GPS
- CIE 415 Professional Practice Issues

For students who desire specialization in construction engineering and management, the following Technical Electives are recommended:

- CIE 429 Reinforced Concrete Design
- CIE 491 Construction Estimating
- CIE 493 Project Management
- EAS 480 Technical Communications (permission of instructor required)

In addition to the above courses, students may obtain field experience by enrolling in an engineering internship/co-op course, which may be used as a technical elective during the senior year. Currently, internships are available with several firms that specialize in construction management engineering.

#### **ENVIRONMENTAL ENGINEERING**

Environmental engineering addresses diverse problems such as drinking water supply, air pollution control, carbon management and global warming, energy, hazardous waste management, storm water and wastewater management, solid waste disposal, public health, and ecosystem management. Environmental engineering is a multidisciplinary profession that blends engineering principles with the natural sciences (chemistry, biology, and geology), mathematics, statistics, and computer science. Environmental engineers find employment in a wide range of positions including engineering consulting firms, industry, government agencies, municipalities, public and private laboratories, research organizations, and educational institutions.

The Department of Civil, Structural and Environmental Engineering offers a BS degree in environmental engineering, as well as a specialization track within the BS civil engineering program. The track is

designed to equip students for a variety of career opportunities. As part of the required civil engineering curriculum, all students take the following courses related to environmental engineering:

- CIE 340 Environmental Engineering
- CIE 343 Hydraulic Engineering
- CIE 354 Fluid Mechanics

For students who desire additional specialization in environmental engineering within the civil engineering program, the following Technical Electives are recommended:

- CIE 441 Ecological Engineering
- CIE 442 Treatment Process Engineering
- CIE 449 Environmental Engineering Design

Other environmental engineering Technical Electives include:

- CIE 444 Hydrologic Engineering
- CIE 445 Groundwater Engineering
- CIE 447 Environmental Engineering Practicum
- CIE 448 Chemical Principles of Environmental Engineering
- CIE 469 Hazardous Waste Management
- EAS 480 Technical Communications (permission of instructor required)

In addition to the above courses, students may obtain field experience by enrolling in an engineering internship/co-op course, which may be used as a Technical Elective during the senior year. Currently, internships are available with several consulting firms and government agencies that specialize in environmental engineering.

## **GEOTECHNICAL ENGINEERING**

Geotechnical engineering plays a vital role in the design and construction of the nation's civil infrastructure against natural forces, as well as in its maintenance and rehabilitation. Geotechnical engineers design foundations, ground improvement, slopes and embankments, retaining walls, dams, landfills, shoring, underpinning of structures, below-ground waste containment, soil clean-up, landfills, and wetland drainage systems. They also work in conjunction with environmental engineers in the areas of solid waste management and groundwater protection to maintain the quality of our land and groundwater resources.

The Department of Civil, Structural and Environmental Engineering offers a broad-based education in civil engineering designed to equip students for a variety of career opportunities. As part of the required civil engineering curriculum, all students take the following courses related to geotechnical engineering:

- EAS 209 Mechanics of Solids
- CIE 354 Fluid Mechanics
- CIE 334 Soil Mechanics
- CIE 435 Foundation Engineering

For students interested in a specialization in geotechnical engineering, the following Technical Electives are recommended:

- CIE 438 Structural Design and Construction of Foundations
- CIE 458 Introduction to Geoenvironmental Engineering
- CIE 476 Design and Construction of Earth Structures

Other relevant Technical Electives include:

- CIE 426 Finite Element Structural Analysis
- CIE 429 Reinforced Concrete Design
- CIE 437 Pavement Design and Materials
- EAS 480 Technical Communications (permission of instructor required)

In addition to the above courses, students may obtain field experience by enrolling in an engineering internship/co-op course, which may be used as a Technical Elective during the senior year. Currently, internships are available with several consulting firms that specialize in geotechnical engineering.

## **STRUCTURAL ENGINEERING**

Structural engineering focuses on the design and analysis of different types of structural systems. All structures, regardless of their function, are subjected to natural forces (gravity, wind, water and earthquakes) and by man-made forces (cargo and automobile traffic). They must be designed to withstand these forces. These structures can be as varied as buildings, bridges, pipelines, machinery, automobiles, and spacecraft. The job of the structural engineer is to create new designs or to evaluate and improve the capabilities of existing structures. To accomplish this, the structural engineer must be knowledgeable about the behavior of deformable bodies; about the sources, magnitudes and probability of occurrence of applied loads; about material properties, design philosophies and governmental design codes; and about computer programming and usage. As most of the building codes have seismic design requirements, structural engineers must also learn about the earthquake-resistant design of new structures and the seismic retrofitting of existing structures.

The Department of Civil, Structural and Environmental Engineering offers a broad-based education in civil engineering designed to equip students for a variety of career opportunities. As part of the required civil engineering curriculum, all students take the following courses related to structural engineering:

- EAS 209 Mechanics of Solids
- CIE 323 Structural Engineering I
- CIE 324 Structural Engineering II

For students who desire additional specialization in structural engineering, the following Technical Electives are recommended:

- CIE 423 Structural Engineering III
- CIE 428 Steel Design
- CIE 429 Reinforced Concrete Design
- CIE 430 Wood Design

Other relevant Technical Electives include:

- CIE 424 Computer Aided Design in Civil Engineering
- CIE 426 Finite Element Structural Analysis
- CIE 438 Structural Design & Construction of Foundations
- EAS 480 Technical Communications (permission of instructor required)

In addition to the above courses, students may obtain field experience by enrolling in an engineering internship/co-op course, which may be used as a Technical Elective during the senior year. Currently, internships are available with several consulting firms that specialize in structural engineering.

## 4. SPECIAL PROGRAMS

### 4.1 OVERVIEW

Students pursuing the BS degree in civil engineering have a number of opportunities to enhance their academic program of study through study abroad, work experiences, and combined degrees. Interested students should contact the Director of Undergraduate Studies to discuss current opportunities.

### 4.2 STUDY ABROAD

Study abroad programs are available to all UB students interested in enhancing their undergraduate or graduate degree, regardless of academic field. For details, visit the UB Study abroad [webpage](#). UB is also a participant in the [Global Engineering Education Exchange](#) (Global E<sup>3</sup>). Recently, civil engineering students have participated in study-abroad programs at the University of Troyes (France), University of Limerick (Ireland), and Beijing Polytechnic University (China).

### 4.3 WORK EXPERIENCE

Recent surveys of employers of UB civil engineering graduates have indicated that prior work experience is an important factor in hiring and promotion. There are two primary means of obtaining external work experience while pursuing the BS civil engineering degree:

1. The Engineering Career Institute (ECI), a work experience program administered by the School of Engineering and Applied Science, is offered every summer to students who have completed their junior-year coursework. Students participating in ECI register for EAS 396 in the spring of their junior year and receive one academic credit. Then they register for EAS 496 over the summer and receive two additional academic credits while performing paid full-time summer work for an approved civil engineering employer. For details, see the [ECI webpage](#).
2. The civil engineering co-op (CIE 408) provides 3 credits of academic coursework that can be counted as a Technical Elective. Students typically work for an approved civil engineering employer on a part-time basis (paid or unpaid) during a senior-year academic semester, and must submit a written report and oral presentation at the end of the internship summarizing their experience. For details, contact the Director of Undergraduate Studies.

In meeting the civil engineering degree requirements, only three credits of work experience coursework may be counted as a Technical Elective.

### 4.4 BS (CIVIL ENGINEERING)/MBA COMBINED-DEGREE PROGRAM

The Department of Civil, Structural and Environmental Engineering and the School of Management offer a five-year program leading to a combined degree in BS (Civil Engineering)/MBA (Masters in Busi-

ness Administration). This program reduces, by one year, the usual pattern of a four-year undergraduate degree and a two-year MBA program.

Students wishing to pursue the joint program should take the *Graduate Mathematics Admissions Test* (GMAT) and apply to the MBA program during their junior year. Applications are considered on a rolling basis beginning in January, with July 1 as the target deadline. Currently, the middle 80 percent of admitted students have GMAT scores in the range 560 – 670.

Candidates must meet all the degree requirements of each program, except for the reduction of 18 credit hours in the total credit hours required for the usual pattern of a four-year BS (Civil) degree and a two-year MBA degree. Students entering the eighth semester of this program will be considered graduate students and charged tuition at the graduate rate from that point on.

Applications for the joint five-year program may be obtained from the MBA Program Office in 206 Jacobs. Additional information and a current summary of the curriculum can be found [here](#).

## 5. ASSESSMENT AND EVALUATION – A PEEK UNDER THE HOOD

### 5.1 OVERVIEW

To many students, the curriculum they follow to get their degree reads like a magical list of courses that someone long ago thought was the path towards graduation. Engineers are different. We follow a very formal procedure for getting you from where you are to the end of your career. *You are a big part of the process.*

The process is described below in detail. Briefly, we start with defining the people important to the program (*constituents* – this includes you). We ask the constituents (including you through the Senior Exit Survey starting in 2009) for help in identifying the appropriate career achievements for a civil engineer (*program educational objectives*). Periodically, we ask alumni and employers if our graduates have met these achievements. We created a list of skills and knowledge that you need at the end of your senior year in order to achieve the career objectives. Items on this list are called the *program outcomes*. The curriculum is designed to help you achieve the program outcomes. We check your work throughout your time here and ask for your opinion to determine whether you have achieved the program outcomes. In the vernacular of higher education, the program is *outcomes based* (based on what you know and can do, not based on what is covered in class) and devoted to *continuous improvement*.

### 5.2 ACCREDITATION

UB's civil engineering program is accredited by [ABET, Inc.](#) With an ABET-accredited BS degree, graduates eventually may apply for registration as a Professional Engineer (PE) (see Section 1.3). ABET conducts reviews of undergraduate programs for accreditation at 6-year intervals. The most recent review of the civil engineering program took place in December, 2002. Our next ABET review is scheduled for October, 2008.

The Department of Civil, Structural and Environmental Engineering has developed a program of self-evaluation and continuous improvement designed to sustain a civil engineering education of increasing high quality and meet the accreditation requirements of ABET. Details regarding the current status of ABET-accreditation activities are available from the Department web site. Key components of this program include:

- Definition of the *constituents* served by the civil engineering program
- Establishment of *program educational objectives* with our constituents
- Establishment of *program outcomes*, in conjunction with ABET and ASCE
- An ongoing program of *assessment* that measures the degree to which the program educational objectives and program outcomes are being met
- An ongoing program of *evaluation* to improve the civil engineering program in response to feedback from the assessment process

## **5.3 CONSTITUENTS**

The constituencies of the civil engineering program include:

- Current students in the civil engineering program and their families
- Department faculty
- Other faculty in the School of Engineering and Applied Sciences
- Other faculty of the University at Buffalo
- Employers who participate in the Engineering Career Institute and the civil engineering internship and co-op programs
- Graduate and professional schools
- Employers of civil engineering graduates, including engineering consulting firms, government agencies, manufacturing and construction companies, and educational and research institutions
- Program alumni

## **5.4 PROGRAM EDUCATIONAL OBJECTIVES**

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing you to achieve. Consistent with the mission and vision of the Department, the program educational objectives of the civil engineering program are to:

- Be employed and promoted as civil engineers in consulting, industry, government, and academia or employed and promoted in related professions.
- Maintain state-of-the-art knowledge through lifelong learning, such as graduate study and continuing education.
- Respond to the changing impact of civil engineering solutions in a global and social context.
- Advance and support the engineering profession through participation in professional societies, civic groups, and educational institutions.

## **5.5 PROGRAM OUTCOMES**

Consistent with the program educational objectives outlined above, graduates of the civil engineering program should be able to:

- solve problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science
- design a civil engineering experiment to meet a need; conduct the experiment, and analyze and interpret the resulting data

- design a complex system or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- function effectively as a member of a multi-disciplinary team
- solve well-defined engineering problems in four technical areas appropriate to civil engineering
- analyze a complex situation involving multiple conflicting professional and ethical interests, to determine an appropriate course of action
- organize and deliver effective verbal, written, and graphical communications
- determine the global, economic, environmental, and societal impacts of a specific, relatively constrained engineering solution
- demonstrate the ability to learn on their own, without the aid of formal instruction
- incorporate specific contemporary issues into the identification, formulation, and solution of a specific engineering problem
- apply relevant techniques, skills, and modern engineering tools to solve a simple problem

A more detailed list of program outcomes may be found in Appendix C. In each course syllabus, you will see how the course relates to the outcomes in Appendix C. For example, a course linked to “3a(K)” will help you “solve problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science.”

## **5.6 ASSESSMENT**

Formal assessment activities were initiated in 1999 with the first exit survey of civil engineering seniors. End-of-semester surveys and the senior exit survey are a component of the Department’s self-assessment. Since the 2002 ABET visit, assessment efforts have been expanded to include examination of student work to determine if program outcomes are being achieved. This effort includes a comprehensive examination of student work, student experiences in co-ops, and performance data from the Fundamentals of Engineering exam.

Program educational objectives were developed with the assistance of a target group of employers and other constituents. Program educational objectives are assessed through employer and alumni surveys

## **5.7 EVALUATION AND CONTINUOUS IMPROVEMENT**

In response to the feedback received from the assessment program, the Department is engaged in an ongoing program of self-improvement. Recent examples of these activities include:

- Revisions to the program Educational Objectives assessment process

- Revisions to the program Outcomes based on the ASCE Body of Knowledge
- Execution of a pilot study to design the program outcome assessment and evaluation process
- Addition of primary data sources to the assessment process for program outcomes
- Inclusion of professional development milestones
- Expansion of the transportation faculty and course offerings
- Cumulative design experience revisions
- Increase in the credit hours of the laboratory courses
- Prerequisite enforcement
- Standardization of course syllabi
- Student computing laboratory rehabilitation
- Undergraduate Studies secretary hired
- Redistribution of assessment/evaluation responsibilities
- Career Services specialist in engineering

# APPENDIX A. TYPICAL FLOWSHEET

Name: \_\_\_\_\_  
 Person Number: \_\_\_\_\_  
 Previous Colleges Attended: \_\_\_\_\_  
 Date Admitted to UB: \_\_\_\_\_ Major: \_\_\_\_\_ Expected Graduation: \_\_\_\_\_

**CIVIL ENGINEERING**  
**STATE UNIVERSITY OF NEW YORK AT BUFFALO**  
 Fall 2007 Updates

Fall		Spring		Fall		Spring		Fall		Spring	
4		4		4		4		3		3	
MTH 141	Calculus 1	MTH 142	Calculus 2	MTH 241	Calculus 3	MTH 306	Diff Eq	CIE 354	Fluid Mech	CIE 343	Hydraulics
3		3		3		3		3		3	
CHE 107	Chem 1	CHE 108	Chem 2	EAS 207	Statics	EAS 208	Dynamics	CIE 323	Struct 1	CIE 324	Struct 2
3		4		4		3		3		3	
EAS 140	Eng Solutions	PHY 107	Physics 1	PHY 108	Physics 2	EAS 209	Mech of Solids	CIE 327	Materials	CIE 334	Mech of Soils
1		2		1		3		3		3	
CIE 101	Great Creations	MAE 177	Engin Drawing	PHY 158	Physics 2 Lab	Engineering Elective **		CIE 308	Eng Statistics	CIE 340	Env. Eng.

Date	Xfer	S/P	U

Engineering Courses					
Date	HR	QP	Cumulative		
			HR	QP	QPA

\*Choose from: CIE 428, 429, 430, 438, 442 or 449

\*\*Engineering Elective: Choose from EE 200, EE 202, MAE 204, IE 320, CSE 114

3-4	
EAS 230 or	CSE 113

3	
CIE 303	Geodesy/GIS/GPS

2	
CIE 362	Civil Eng Lab II

3	
Applied Math	Elective ***

\*\*\*Applied Math Elective: EAS 451, MAE 376, MTH 417, MTH 418, MAE 428 or MTH 309

**General Education**

	Writing Skills		Humanities	
A <sup>1</sup>	3	3	3	3
B <sup>1</sup>	ENG 101	ENG 201		
C <sup>1</sup>	ESL 407	ESL 408		

2	
CIE 361	Civil Eng Lab I

read across row

<sup>1</sup> One Set of Writing Skills/Humanities (A or B or C) as determined by placement

3		3		3		3		S		Library Skills Workbook
UGC 111 <sup>2</sup>	World Civ. I	UGC 112 <sup>2</sup>	World Civ. II	Am. Plural <sup>2</sup>	A <sup>2</sup>					

<sup>2</sup> Transfer students should consult with an advisor


Overall						
Date	HR	QP	Cumulative			Status
			HR	QP	QPA	

## APPENDIX B. IMPORTANT CONTACTS

### People

Name	Extension	Room	Email Address	Function
<b>DEPARTMENT OF CIVIL, STRUCTURAL AND ENVIRONMENTAL ENGINEERING</b> (all phone numbers: 716-645-2114)				
A. Scott Weber	x2446	212 Ketter	<a href="mailto:chaircie@buffalo.edu">chaircie@buffalo.edu</a>	Department Chair
James N. Jensen	x2329	207 Jarvis	<a href="mailto:jjensen@eng.buffalo.edu">jjensen@eng.buffalo.edu</a>	Director of Undergraduate Studies
Cherrie Robbins	x2332	207 Jarvis	<a href="mailto:robbins4@eng.buffalo.edu">robbins4@eng.buffalo.edu</a>	Undergraduate Secretary
<b>SCHOOL OF ENGINEERING AND APPLIED SCIENCES</b> (all phone numbers: 716-645-2774)				
Name	Extension	Room	Email Address	Function
John Van Benschoten	x1130	410 Bonner	<a href="mailto:jev@eng.buffalo.edu">jev@eng.buffalo.edu</a>	Assoc. Dean for Undergraduate Education
Kerry Collins-Gross	x1119	410 Bonner	<a href="mailto:collinsk@buffalo.edu">collinsk@buffalo.edu</a>	Senior Academic Advisor: Civil
Jane Sinclair	x1117	410 Bonner	<a href="mailto:jsinclai@eng.buffalo.edu">jsinclai@eng.buffalo.edu</a>	Transfer Specialist
Bill Wild	x1214	301 Bonner	<a href="mailto:wgwild@eng.buffalo.edu">wgwild@eng.buffalo.edu</a>	Director of Special Student Programs

### Web Sites

Site	Address	Function
Department of Civil Structural and Environmental Engineering (CSEE)	<a href="http://www.csee.buffalo.edu">http://www.csee.buffalo.edu</a>	Departmental information
School of Engineering and Applied Science (SEAS)	<a href="http://www.eng.buffalo.edu">http://www.eng.buffalo.edu</a>	School information
University at Buffalo (UB)	<a href="http://www.buffalo.edu">http://www.buffalo.edu</a>	Access to University information
MyUB	<a href="http://myub.buffalo.edu">http://myub.buffalo.edu</a>	Student access to grades, class schedules, and other general information
SEAS Office of Undergraduate Education	<a href="http://www.eng.buffalo.edu/currentundergraduate.php">http://www.eng.buffalo.edu/currentundergraduate.php</a>	Detailed information and services for engineering students
Student Response Center	<a href="http://www.src.buffalo.edu">http://www.src.buffalo.edu</a>	Student access to registration, DARS, course offerings, calendars, financial aid, billing, etc.
Office of Student Affairs	<a href="http://www.student-affairs.buffalo.edu">http://www.student-affairs.buffalo.edu</a>	Services and programs to support the social, interpersonal, and emotional growth of UB students.
Transfer and Articulation Services	<a href="http://taurus.buffalo.edu">http://taurus.buffalo.edu</a>	Information about course transfers
Career Services	<a href="http://www.ub-careers.buffalo.edu">http://www.ub-careers.buffalo.edu</a>	Information on careers, summer jobs, and the GRE
Engineering Career Institute	<a href="http://www.eng.buffalo.edu/Outreach/new_work02.html">http://www.eng.buffalo.edu/Outreach/new_work02.html</a>	Information on co-ops, internships

## APPENDIX C. PROGRAM OUTCOMES AND PERFORMANCE CRITERIA

For assessment purposes, the program outcomes have been divided into performance criteria as follows:

Outcome	Description	Performance Criteria				
		Knowledge	Comprehension	Application	Analysis	Synthesis
3(a)	<b>solve</b> problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	<b>define</b> key factual information related to mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	<b>explain</b> key concepts and problem-solving processes in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science	<b>solve</b> problems in mathematics through differential equations, calculus-based physics, chemistry, and one additional area of science		
3(b)	<b>design</b> a civil eng. experiment to meet a need; <b>conduct</b> the experiment, and <b>analyze</b> and <b>interpret</b> the resulting data	<b>identify</b> the procedures and equipment necessary to conduct civil eng. experiments	<b>explain</b> the purpose, procedures, equipment, and practical applications of civil eng. experiments	<b>conduct</b> civil eng. experiments according to established procedures, and <b>report</b> the results	<b>conduct</b> civil eng. experiments according to established procedures, and <b>analyze</b> and <b>interpret</b> the results	<b>design</b> a civil eng. experiment to meet a need; <b>conduct</b> the experiment, and <b>analyze</b> and <b>interpret</b> the resulting data
3(c)	<b>design</b> a complex system or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	<b>define</b> eng. design; <b>list</b> the major steps in the eng. design process; and <b>list</b> constraints that affect the process and products of eng. design	<b>describe</b> the eng. design process; <b>explain</b> how real-world constraints affect the process and products of eng. design	<b>design</b> a simple component (e.g., a structural member) to meet a well-defined set of requirements and constraints	<b>design</b> a system or process (e.g., a truss or water treatment process) to meet a well-defined set of requirements and constraints	<b>design</b> a complex system or process to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Outcome	Description	Performance Criteria				
		Knowledge	Comprehension	Application	Analysis	Synthesis
3(d)	<b>function</b> effectively as a member of a multi-disciplinary team	<b>list</b> the key characteristics of an effective multi-disciplinary team	<b>explain</b> the factors affecting the ability of a multidisciplinary team to function effectively	<b>Function</b> effectively as a member of a multidisciplinary team		
3(e)	<b>solve</b> well-defined eng. problems in four technical areas appropriate to civil eng.	<b>list</b> key factual information related to four technical areas of civil eng.	<b>explain</b> key concepts and problem-solving processes in four technical areas appropriate to civil eng.	<b>solve</b> well-defined eng. problems in four technical areas appropriate to civil eng.		
3(f)	<b>analyze</b> a complex situation involving multiple conflicting professional and ethical interests, to determine an appropriate course of action	<b>list</b> the professional and ethical responsibilities of a civil engineer	<b>explain</b> the professional and ethical responsibilities of a civil engineer	<b>apply</b> standards of professional and ethical responsibility in a relatively clear-cut situation, to determine an appropriate course of action	<b>analyze</b> a complex situation involving multiple conflicting professional and ethical interests, to determine an appropriate course of action	
3(g)	<b>organize</b> and <b>deliver</b> effective verbal, written, and graphical communications	<b>list</b> the characteristics of effective verbal, written, and graphical communications	<b>describe</b> the characteristics of effective verbal, written, and graphical communications	Correctly <b>apply</b> the rules of grammar and composition in verbal and written communications; and <b>apply</b> appropriate graphical standards in preparing eng. drawings	<b>organize</b> and <b>deliver</b> effective verbal, written, and graphical communications	

Outcome	Description	Performance Criteria			Analysis	Synthesis
		Knowledge	Comprehension	Application		
3(h)	<b>determine</b> the global, economic, environmental, and societal impacts of a specific, relatively constrained eng. solution	drawing upon a broad education, graduates can <b>identify</b> global, economic, environmental, and societal impacts of eng. solutions	drawing upon a broad education, graduates can <b>explain</b> the global, economic, environmental, and societal impacts of eng. solutions	drawing upon a broad education, graduates can <b>determine</b> the global, economic, environmental, and societal impacts of a specific, relatively constrained eng. solution		
3(i)	<b>demonstrate</b> the ability to learn on their own, without the aid of formal instruction	<b>define</b> life-long learning	<b>explain</b> the need for life-long learning and <b>describe</b> the skills required of a life-long learner	<b>demonstrate</b> the ability to learn on their own, without the aid of formal instruction		
3(j)	<b>incorporate</b> specific contemporary issues into the identification, formulation, and solution of a specific eng. problem	<b>list</b> contemporary issues that affect eng. problems	<b>explain</b> how contemporary issues affect the identification, formulation, and solution of eng. problems	<b>incorporate</b> specific contemporary issues into the identification, formulation, and solution of a specific eng. problem		
3(k)	<b>apply</b> relevant techniques, skills, and modern eng. tools to solve a simple problem	<b>identify</b> the techniques, skills, and modern eng. tools that are necessary for eng. practice	<b>explain</b> how these techniques, skills, and modern eng. tools are used in eng. practice	<b>apply</b> relevant techniques, skills, and modern eng. tools to solve a simple problem		