

GRADUATE PROGRAM AND DEGREE REQUIREMENTS

Civil Engineering Environmental Engineering

Effective Fall 2017

Master of Engineering (M.Eng.)

Master of Science (M.S.)

Doctor of Philosophy (Ph.D.)

Department of Civil and Environmental Engineering
The Pennsylvania State University
216 Sackett Building
University Park, PA 16802
Phone: 814-863-3085
Fax: 814-863-7304
www.engr.psu.edu/ce

Contents

PART I: INTRODUCTION	4
PROGRAM OVERVIEW	4
PROGRAM MISSION AND GOALS	4
DISTINCTIVE FEATURES AND PROGRAM EMPHASES	5
GRADUATE STUDIES AND RESEARCH	5
CHANGE OF DEGREE.....	5
SUPPORT STAFF.....	5
FACULTY RESEARCH AREAS	7
Environmental Engineering	7
Geotechnical and Materials Engineering	8
Structural Engineering and Mechanics	9
Transportation Engineering	10
Water Resources Engineering.....	11
PART II: ADMISSION AND ENTRANCE REQUIREMENTS	12
ADMISSION REQUIREMENTS	12
M.ENG and M.S. ENTRANCE REQUIREMENTS.....	12
PH.D. ENTRANCE REQUIREMENTS	14
ASSESSMENT CONSIDERATIONS	15
PART III: ADMISSION TO PROGRAM AND INITIAL PROGRESSION	12
DEVELOPING A PLAN OF STUDY	16
STUDENT ACADEMIC SUPPORT	16
CHANGING ADVISERS.....	16
SARI REQUIREMENTS	17
SUPPORT SERVICES.....	17
PART IV: GRADUATE SCHOOL DEGREE REQUIREMENTS	19
PART V: MASTER OF ENGINEERING REQUIREMENTS	19
DEGREE DESCRIPTION AND CREDIT REQUIREMENTS.....	19
AREAS OF SPECIALIZATION FOR M.ENG. IN CIVIL ENGINEERING	19
M.ENG. IN ENVIRONMENTAL ENGINEERING.....	19
CONTINUOUS REGISTRATION	19
ADVISER/ADVANCED DEGREE COURSE PLAN.....	21
PART VI: MASTER OF SCIENCE REQUIREMENTS	22
DEGREE DESCRIPTION AND CREDIT REQUIREMENTS.....	22
M.S. IN CIVIL ENGINEERING.....	22

M.S. IN ENVIRONMENTAL ENGINEERING.....	23
CONTINUOUS REGISTRATION	24
ACADEMIC ADVISER/ADVANCED DEGREE COURSE PLAN	24
SELECTION OF THESIS SUPERVISOR.....	24
THESIS REQUIREMENTS	24
ADVISORY COMMITTEE/THESIS PROPOSAL.....	25
FINAL THESIS APPROVAL	26
PART VII: DOCTORAL REQUIREMENTS	27
DEGREE DESCRIPTION AND CREDIT REQUIREMENTS.....	27
CANDIDACY EXAMINATIONS.....	27
DOCTORAL COMMITTEE AND COMPREHENSIVE EXAMINATION	30
CONDUCTING RESEARCH	33
WRITING AND DEFENDING THE DOCTORAL DISSERTATION	33
FINAL DISSERTATION DOCUMENT	34
GRADUATION.....	34

PART I: INTRODUCTION

PROGRAM OVERVIEW

The Penn State Civil and Environmental Engineering (CEE) Department, established in 1881, is internationally recognized for excellence in the preparation of undergraduate and graduate engineers through the integration of education, research, and leadership. In 2017, the Civil Engineering undergraduate program was ranked 14th by U.S. News and World Report, the graduate program in Civil Engineering was ranked 21st, and the graduate program in Environmental Engineering was ranked 15th. More than 400 juniors and seniors are enrolled in the undergraduate program, and approximately 120 students in the graduate program, with about 60% pursuing doctoral degrees. Penn State is a large research university, and the CEE Department, with its 33 tenure track faculty members and full time instructors, performs \$15,000,000 of research annually, and 90,000 peer reviewed paper citations indexed by Thomson's Web of Science. The Department's faculty has received a number of prestigious honors including NAE membership and 7 NSF CAREER awards.

The CEE graduate program offers six graduate degrees: Master of Engineering (M.Eng.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) in either Civil Engineering or in Environmental Engineering. Within Civil Engineering, graduate students can specialize in one of four areas: Geotechnical and Materials Engineering, Structural Engineering and Mechanics, Transportation Engineering, or Water Resources Engineering. Students with interests in both Water Resources Engineering and Environmental Engineering may choose either the Civil or Environmental degree options. To earn each of graduate degree requires the student to meet specific requirements of both the Pennsylvania State University Graduate School and the Department of CEE. This handbook describes the departmental programs and requirements for each degree. This handbook is to be considered a supplement to the Graduate Degree Programs Bulletin. Students are advised to consult the Graduate Bulletin at: <http://www.psu.edu/bulletins/whitebook> for Graduate School degree requirements. Students should direct specific inquires with respect to the CEE graduate programs to the following:

Graduate Officer

Dr. William D. Burgos
115 Sackett Building
University Park, PA 16802
814-863-0578
wdb3@psu.edu

Graduate Staff Assistant

Ms. Judy Heltman
216 Sackett Building
University Park, PA 16802
814-863-3085
jheltman@enr.psu.edu

This handbook is divided into seven parts. Part I discusses the CEE graduate program mission and goals, distinctive features of the program and program emphasis areas, graduate studies and research support staff, faculty and areas of study. Part II discusses developing a Plan of Study, Academic support, and adviser and student responsibilities. Part III describes the Graduate School degree requirements. Part IV, V, and VI describe the graduate degree requirements for each of the programs.

PROGRAM MISSION AND GOALS

The mission of the Department of Civil and Environmental Engineering is to prepare students for professional practice, graduate study, lifelong learning, societal leadership and to improve the scientific and technological basis for civil and environmental engineering practice. To fulfill this mission, the Department seeks to provide a high quality undergraduate program with instruction in all fundamental areas of civil engineering, to conduct a distinguished program of research and graduate study in selected areas of civil and environmental engineering, and to disseminate advanced technical knowledge to engineers, other professionals, and the public.

DISTINCTIVE FEATURES AND PROGRAM EMPHASES

The graduate programs at the Pennsylvania State University in Civil and Environmental Engineering consist of Environmental Engineering, Geotechnical and Materials Engineering, Structural Engineering and Mechanics, Transportation Engineering, and Water Resources Engineering. Graduate enrollment over five years (2009-2014) has averaged 102 Master's students and 109 Doctoral students. The research mission of the graduate program is supported by state of the art facilities located at Civil Infrastructure Testing and Evaluation Laboratory (CITEL), the Kappe Environmental Engineering Laboratories, and the Larson Transportation Institute (LTI) Test Track, in addition to other labs in Sackett and Hammond Buildings. Several institutes and centers support research activities, particularly, the Larson Transportation Institute (LTI), the Penn State Institutes of Energy and the Environment (PSIEE), the Materials Research Institute (MRI), and the Pennsylvania Housing Research Center (PHRC).

GRADUATE STUDIES AND RESEARCH

The CEE Department offers graduate degrees in Civil Engineering and in Environmental Engineering. The Master of Engineering (M.Eng.) degree is designed for students seeking an advanced degree to enter professional practice. The M.Eng. degree is a coursework-only program that students are required to start in the Fall semester and is designed for completion within one year. The M.Eng. degree requires a total of 31 credits of course work including the one-credit colloquium, CE 590. The Master of Science (M.S.) degree is intended for students conducting research in a specialization area within CEE. The M.S. degree requires completion of 24 credits of coursework, a six-credit thesis, and the one-credit colloquium CE 590 (31 total credits). The M.S. degree (including the thesis) is designed for completion within two years. The Doctor of Philosophy (Ph.D.) degree is intended for students seeking in-depth knowledge in a specialization area within CEE, and completing dissertation research at a level above that for an M.S. degree. Ph.D. graduates typically pursue faculty positions, research positions in industry, state, or governmental institutions.

CHANGE OF DEGREE

A graduate student who has been admitted for an academic degree program who wants to change from one type of degree to another must complete a "Resume Study/Change of Degree or Major" form and submit the request to the Office of Graduate Enrollment Services for approval.

SUPPORT STAFF

The Graduate & Undergraduate Academic Programs Offices manage all Department of Civil and Environmental Engineering undergraduate programs, graduate programs, scholarships and fellowships, course and classroom scheduling, and web page administration. A computer systems technician and assistant provide IT support for the computer network and large number of computers operated within the department. A laboratory supervisor and technician are available to provide support for instruction and research in the departmental laboratories. Additional technical staff provides support for research conducted at other research laboratories housed outside the CEE Department. Additional staff supports the departmental central office and two research centers housed within the CEE Department.

Table I.1: Department of Civil & Environmental Staff

Sherry Boone	Financial Assistant	slb31@engr.psu.edu	212 Sackett Bldg.
Amy Bordas	CITEL/Administrative Support Assistant	ajm114@psu.edu	107 CITEL
Amy Case	Administrative Support Assistant	acase@engr.psu.edu	212 Sackett Bldg.
Tracy Dorman	PHRC Meeting & Events Coordinator	tdorman@engr.psu.edu	206B Sackett Bldg.
Rachel Fawcett	PHRC Budgets & Publications Coordinator	rjf5092@psu.edu	206B Sackett Bldg.
David Faulds	Lab Supervisor	dfaulds@engr.psu.edu	114 Sackett Bldg.
Dan Fura	CITEL/Lab Supervisor	dff10@psu.edu	169-3 CITEL
Heather Hamby	UG Staff Assistant	hehce@engr.psu.edu	218 Sackett Bldg.
Matt Hassinger	Engineering Aide	mhassinger@engr.psu.edu	8B Sackett Bldg.
Judy Heltman	Graduate Staff Assistant	jheltman@engr.psu.edu	216 Sackett Bldg.
Michelle Hill	Dept. Head Staff Assistant	mvm3@psu.edu	212 Sackett Bldg.
Christopher Hine	PHRC Housing & Land Dev Specialist	clh399@psu.edu	206E Sackett Bldg.
David Jones	Research Support Assistant	dwj123@psu.edu	125 Sackett Bldg.
Allan Knisely	IT Consultant	ahk11@psu.edu	206K Sackett Bldg.
Amy Long	Administrative Coordinator	along@engr.psu.edu	215A Sackett Bldg.
Sarah K. Lowe	PHRC Housing Systems Specialist	sek175@psu.edu	206D Sackett Bldg.
Jennifer Matthews	Communications Strategist	jas6149@psu.edu	212 Sackett Bldg
Bourke Maddox	IT Support Specialist	bmaddox@engr.psu.edu	206H Sackett Bldg.
Heather Weikel	Environmental Staff Assistant	hweikel@engr.psu.edu	206L Sackett Bldg.
Brian Wolfgang	PHRC Associate Director	bmw5014@psu.edu	206C Sackett Bldg.

FACULTY RESEARCH AREAS

Environmental Engineering

The environmental engineering program includes faculty who specialize in the areas of acid mine drainage treatment, bioenergy production, bioremediation, ecological engineering, environmental microbiology, impacts of unconventional oil and gas development, renewable energy production, sustainable environmental technologies, water chemistry, and water and wastewater treatment.

Rachel A. Brennan, Associate Professor, 231K Sackett Bldg., rbrennan@engr.psu.edu, 814-865-9428. Ecological wastewater treatment (Eco-Machines™); bioremediation of hazardous wastes, emerging contaminants, and acid mine drainage; beneficial reuse of aquatic biomass for the production of fertilizers, feedstocks, and biofuels; self-sustaining aquaponics.

William D. Burgos, Professor/Graduate Officer, 115 Sackett Bldg., wdb3@psu.edu, 814-863-0578. Bioremediation of soil, sediment and groundwater; Biological metal oxidation in coal mine drainage; Biological iron (III) reduction; Biological uranium (VI) reduction; Environmental impacts of shale gas development.

Fred S. Cannon, P.E., Professor, 225 Sackett Bldg., fcannon@psu.edu, 814-863-8754. Water, air, and hazardous waste treatment; activated carbon and surface chemistry.

Christopher Gorski, Assistant Professor, 231F Sackett Bldg., cag981@engr.psu.edu, 814-865-5673. Contaminant fate in engineered and natural systems, aquatic geochemistry, environmental redox chemistry.

Li Li, Associate Professor, 221A Sackett Bldg., lili@engr.psu.edu, 814-867-0151. Water quality modeling, watershed hydrogeochemistry, reactive transport, contaminant transport and fate.

Bruce E. Logan, Kappe Professor, 231Q Sackett Bldg., blogan@psu.edu, 814-863-7908. Bioenergy production using exoelectrogenic microorganisms; renewable energy production using waste heat and salinity gradient energy; environmental and chemical transport processes; bioremediation; and biological wastewater treatment.

John M. Regan, P.E., Professor, 220 Sackett Bldg., jregan@engr.psu.edu, 814-865-9436. Biological nutrient removal and transformations; conversion of organics into energy carriers through bioelectrochemical systems, anaerobic digestion, and fermentative hydrogen production; molecular microbial ecology; biofilm systems.

Nathaniel Warner, Assistant Professor, 231D Sackett Bldg., nrw6@engr.psu.edu, 814-865-9423. Environmental impacts of unconventional oil and gas development, salinization of fresh water resources, and application of geochemistry, including isotopes (Sr, B, Ra) to trace fluid interaction, and treatment of oil and gas wastewater and solids.

Geotechnical and Materials Engineering

The geotechnical and materials engineering program focuses on a wide variety of topics for development and use of soil and construction materials. Areas for geotechnical engineering include foundations, landslides, retaining walls, soil-structure interaction, geosynthetics, geoenvironmental, groundwater flow and transport, subsidence, soil dynamics and earthquake engineering. Areas for materials engineering include a wide range of concrete-related research topics, including durability and sustainability of concrete infrastructure, novel high performance cementitious materials, and non-destructive evaluation of civil infrastructure. Pavement engineering emphasizes advanced modeling and testing of transportation materials, bituminous material characterization, pavement design and management, accelerated and full-scale pavement testing, and pavement construction and rehabilitation.

Patrick J. Fox, P.E., Department Head and Shaw Professor, 212 Sackett Bldg., pjfox@engr.psu.edu, 814-863-3084.

Geotechnical and geoenvironmental engineering, subsidence, landfills, groundwater, slope stability, retaining walls, soil dynamics and earthquake engineering.

Tong Qiu, P.E., Associate Professor, 116 Sackett Bldg., tqiu@engr.psu.edu, 814-863-7305.

Geotechnical engineering, soil dynamics, flow through porous media, fluid-solid interaction, landslides, and numerical methods in geotechnical engineering.

Aleksandra Radlińska, Assistant Professor, 231D Sackett Bldg., ara@engr.psu.edu, 814-865-9427.

Cement and concrete in sustainable design, alternative binders, construction materials with reduced CO₂ emission, durability, shrinkage, cracking of concrete, reliability-based analysis of the behavior of construction materials.

Farshad Rajabipour, Associate Professor, 231M Sackett Bldg., farshad@psu.edu, 814-863-0601.

Concrete materials, durability, alkali-silica reaction, green cements and concretes, novel pozzolans, beneficial use of coal combustion products.

Parisa Shokouhi, P.E., Associate Professor, 215B Sackett Bldg., parisa@engr.psu.edu, 814-863-0678.

Non-destructive evaluation of civil infrastructure (numerical modeling, laboratory and field testing), non-destructive material characterization using linear/nonlinear acoustics and ground penetrating radar, monitoring of material degradation, near-surface geophysical investigation, applications of machine learning, and data mining algorithms and multi-sensor data fusion.

Shelley M. Stoffels, P.E., Professor, 208 Sackett Bldg., sms26@engr.psu.edu, 814-865-7254.

Pavement design and rehabilitation, infrastructure management, geotechnical engineering, engineering economics, professional practice issues.

Ming Xiao, P.E., Associate Professor, 231P Sackett Bldg., mxiao@engr.psu.edu, 814-867-0044.

Seepage and erosion, particle transport and multi-phase flow and distribution in porous media, microscopic soil and pore fluid behaviors under in-situ and physicochemically and biologically treated conditions, performance of earth structures for in-service conditions and extreme events, innovative and recycled materials and their engineering applications.

Structural Engineering and Mechanics

Faculty in the structural engineering and mechanics graduate program offer courses in structural mechanics, and analysis and design of structures. The faculty is engaged in research in several fields, including reinforced and prestressed concrete structures, steel structures, bridge engineering, nondestructive bridge evaluation, protective systems, earthquake engineering, structural dynamics, performance based design, structural reliability, building envelope systems, building science and energy efficiency, structural control and health monitoring, multi-hazard risk assessment and mitigation, probabilistic mechanics, solid mechanics, computational mechanics, extreme events modeling and mitigation, inverse methods and optimization, and advanced materials applications.

Michael Hillman, L. Robert and Mary L. Kimball Assistant Professor, 224A Sackett Building, mhillman@psu.edu, 814-863-0623. Computational mechanics; accelerated numerical methods; modeling of extreme events.

Jeffrey A. Laman, P.E., Professor, 231J Sackett Bldg., jlaman@psu.edu, 814-863-0523. Bridge evaluation; bridge vehicle load modeling; testing and dynamics; long-term structural monitoring; fatigue; structural reliability methods; steel design.

Ali Memari, Professor, Hankin Chair of Residential Construction and Director of Pennsylvania Housing Research Center (PHRC), 222 Sackett Bldg., amm7@psu.edu, 814-863-9788. Safety and serviceability of residential building systems and components; full-scale mockup testing and evaluation of building envelope systems under natural hazard and environmental loading conditions; experimental and analytical evaluation of light-frame, masonry; and panelized wall systems for commercial and residential buildings.

Kostas Papakonstantinou, Assistant Professor, 213C Sackett Bldg., kpapakon@psu.edu, 814-863-4010. Stochastic mechanics; risk assessment and management; inverse methods and optimization; structural health monitoring; earthquake engineering and structural dynamics; structural reliability; concrete durability.

Gordon Warn, Associate Professor, 226B Sackett Bldg., gpw1@psu.edu, 814-863-2786. Structural dynamics; analytical modeling of resilience, earthquake engineering, seismic protective systems.

Transportation Engineering

The transportation engineering program covers the areas of transportation planning, design, and operations. Research areas include traffic operations, systems planning for freight, transit and non-motorized travel, travel behavior, transportation planning for emergency response and climate change related issues, infrastructure financing and programming, transportation safety, highway design and performance measures, intelligent transportation systems, human factors and driver behavior, pavement marking materials, statistical and econometric analysis of transportation systems, environmental and ecological aspects of transportation network design, and urban simulation.

Eric T. Donnell, Professor, 231N Sackett Bldg., edonnell@engr.psu.edu, 814-863-7053.

Highway geometric design; speed management; traffic safety.

Vikash Gayah, Assistant Professor, 231L Sackett Bldg., gayah@engr.psu.edu, 814-865-4014.

Traffic operations; transportation network modeling; public transportation systems; urban mobility; traffic safety.

Ilgın Guler, Assistant Professor, 221B Sackett Bldg., iguler@engr.psu.edu, 814-867-6210.

Multi-modal urban transportation; public transportation; traffic operations; infrastructure management; statistical modeling.

Martin T. Pietrucha, P.E., Professor, 221 Sackett Bldg., mtp5@psu.edu, 814-863-7306.

Highway safety; operational effects of highway geometrics; alternative transportation strategies.

Water Resources Engineering

Water Resources Engineering faculty work in the areas of hydraulics, hydrology, water resource management, fluid mechanics, and wave mechanics. Research areas include watershed management, river hydraulics, climate and environmental change impacts on water security, hydroinformatics, hydrologic modeling, uncertainty and reliability, and fundamental aspects of wave mechanics.

Caitlin Grady, Assistant Professor, 226C Sackett Bldg., cgrady@psu.edu, Monitoring and evaluation of international development projects, international environmental treaties, water resources sustainability, network analysis, the food, water, energy nexus.

Xiaofeng Liu, Assistant Professor, 223B Sackett Bldg., xliu@engr.psu.edu, 814-863-2940. Computational fluid dynamics (CFD), environmental fluid mechanics, sediment transport and erosion control, land surface process and morphodynamics, multiphase flow, water quality modeling.

Alfonso Mejia, Assistant Professor, 215B Sackett Bldg., amejia@engr.psu.edu, 814-865-0639. Hydrometeorology, urban hydrology, eco-hydrology, hydro-geomorphology, and water sustainability.

Chaopeng Shen, Assistant Professor, 206C Sackett Bldg., cshen@engr.psu.edu, 814-863-5844. Large scale hydrology, computational hydrology, land surface processes, water-carbon-nutrient interactions under global change, scale issues, subsurface reactive transport modeling, high performance computing.

PART II: ADMISSION AND ENTRANCE REQUIREMENTS

ADMISSION REQUIREMENTS

For any graduate degree offered by the Department of Civil and Environmental Engineering, candidates should possess a baccalaureate degree in engineering from a regionally accredited institution. Students in engineering, physical sciences, or mathematics with a 3.00 grade-point average (on a 4.00 scale) may be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Students without a baccalaureate degree in engineering would be admitted on a provisional basis pending successful completion of entrance requirements (completed concurrently with degree requirements and listed below).

U.S. applicants will upload unofficial copies of their transcripts, a statement of objectives, and three references for letters of recommendation when applying to the program. If admitted, applicants will be required to provide the Graduate School with OFFICIAL transcripts of all their previous course work (in duplicate). In addition, all applicants must submit scores from the General Graduate Record Examinations (GRE) Aptitude Test (verbal, quantitative, and analytical). For the M.Eng. degree, the GRE requirement will be waived for students who have graduated with a degree from the College of Engineering at The Pennsylvania State University with a cumulative grade-point average of greater than 3.30.

International applicants will upload unofficial copies of their transcripts, a statement of objectives, and three references for letters of recommendation when applying to the program. If admitted, applicants will be required to provide the Graduate School with official transcripts (or attested copies), degree, and diploma certificates in **both English and native language**. Photocopies will NOT be accepted. All international applicants whose native language is not English must submit scores for the TOEFL (Test of English as a Foreign Language) or the IELTS (International English Language Testing System). The minimum acceptable score for the TOEFL is 550 for the paper-based test, or a total score of 80 with a 19 on the speaking section for the Internet-based test (iBT). Applicants with iBT speaking scores between 15 and 18 may be considered for provisional admission, which requires completion of specified remedial English courses ESL 114G (American Oral English for Academic Purposes) and/or ESL 116G (ESL/Composition for Academic Disciplines) and attainment of a grade of B or higher. The minimum composite score for the IELTS is 6.5 on all subjects. International applicants who have received a baccalaureate or master's degree from a college, university, or institution in any of the following countries are exempt from the TOEFL requirement: Australia, Belize, British Caribbean and British West Indies, Canada (except Quebec), England, Guyana, Republic of Ireland, Liberia, New Zealand, Northern Ireland, Scotland, the United States, or Wales.

M.ENG. and M.S. ENTRANCE REQUIREMENTS

Students without a baccalaureate degree in engineering must successfully complete entrance requirements (completed concurrently with degree requirements) that are unique for each area of specialization (Tables II.1 to II.4). Therefore, it is unlikely that students without a B.S. degree in engineering will be able to complete their M.Eng degree within one year. Students must take all entrance requirements on an A/F basis and earn a B or better. Students may petition to use other related courses to satisfy these requirements or substitute relevant work experience. Students are encouraged to meet with their academic adviser to discuss these requirements.

Table II.1. Entrance requirements for students without a B.S. engineering degree applying for the M.Eng. (Infrastructure) or the M.S. (Geotechnical and Materials) in Civil Engineering.*

Course Topics	Equivalent Penn State Courses
Advanced mathematics typical of engineering undergraduate programs (calculus through partial differential equations)	MATH 140 Calculus With Analytic Geometry I; and MATH 141 Calculus With Analytic Geometry II; and MATH 251 Ordinary and Partial Differential Equations
One lecture course and one laboratory course in chemistry	CHEM 110 Chemical Principles I; and CHEM 111 Experimental Chemistry
One year of mechanics (statics and strength of materials)	E MCH 211 Statics; and E MCH 213 Strength of Materials
One course in fluid mechanics	C E 360 Fluid Mechanics
One introductory course each in geotechnical engineering, materials, and structures	CE 335 Engineering Mechanics of Soils; and CE 336 Materials Science for Civil Engineers; and CE 340 Structural Analysis
Laboratory experience in soils and materials	CE 337 Civil Engineering Materials Laboratory

* Note that entrance requirements for applicants without a B.S. engineering degree applying for the M.S. or Ph.D. in the Structural Engineering and Mechanics program area will be evaluated on a case-by-case basis.

Table II.2. Entrance requirements for students without a B.S. engineering degree applying for the M.Eng. (Transportation Systems) or the M.S. (Transportation) in Civil Engineering.

Course Topic	Equivalent Penn State Courses
Advanced mathematics typical of engineering undergraduate programs (calculus through partial differential equations)	MATH 140 Calculus With Analytic Geometry I; and MATH 141 Calculus With Analytic Geometry II; and MATH 251 Ordinary and Partial Differential Equations
One course in matrix algebra	MATH 220 Matrices
One course in introductory computer programming	CMPSC 200 Programming for Engineers with MATLAB; or CMPSC 201 Programming for Engineers with C++
One course in basic physics	PHYS 211 General Physics: Mechanics
One course in elementary statistics	STAT 401 Experimental Methods; or STAT 415 Introduction to Mathematical Statistics
One course in introductory transportation engineering	CE 321 Highway Engineering

Table II.3. Entrance requirements for students without a B.S. engineering degree applying for the M.Eng. (Water and Environment) or the M.S. (Water Resources) in Civil Engineering.

Course Topics	Equivalent Penn State Courses
Advanced mathematics typical of engineering undergraduate programs (calculus through partial differential equations)	MATH 140 Calculus with Analytic Geometry I; and MATH 141 Calculus With Analytic Geometry II; and MATH 251 Ordinary Differential and Partial Equations
One year of physics	PHYS 211 General Physics: Mechanics; and PHYS 212 General Physics: Electricity and Magnetism
One year of mechanics (statics and dynamics)	E MCH 211 Statics; and E MCH 212 Dynamics
One course in Fluid Mechanics	CE 360 Fluid Mechanics
One course in Hydrology	CE 461 Water-Resource Engineering

Table II.4. Entrance requirements for students without a B.S. engineering degree applying to the M.Eng. or the M.S. in Environmental Engineering.

Course Topic	Penn State Course
Advanced mathematics typical of engineering undergraduate programs (calculus through partial differential equations)	MATH 140 Calculus With Analytic Geometry I; and MATH 141 Calculus With Analytic Geometry II; and MATH 251 Ordinary and Partial Differential Equations
One lecture course and one laboratory course in chemistry	CHEM 110 Chemical Principles I; and CHEM 111 Experimental Chemistry
One year of physics	PHYS 211 General Physics: Mechanics; and PHYS 212 General Physics: Electricity and Magnetism
One course in fluid hydraulics or mechanics	C E 360 Fluid Mechanics
One introductory course in environmental engineering	CE 370 Introduction to Environmental Engineering; or CE 371 Water and Wastewater Treatment

PH.D. ENTRANCE REQUIREMENTS

In most situations, Ph.D. candidates begin their program after completion of a Master's degree (M.Eng. or M.S.) and should meet all core course requirements for their specialization area (detailed in Tables VI.1 to VI.5). Exceptional applicants are encouraged to apply for Direct Entry into the Ph.D. program (i.e. entering the program without first completing a Master's degree).

ASSESSMENT CONSIDERATIONS

Additional admissions information is available at the Graduate School website: <http://www.psu.edu/bulletins/whitebook/>. The Pennsylvania State University is committed to an equal access policy for all persons, assuring equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. It is the policy of the University to maintain an academic and work environment free of discrimination, including harassment. The Pennsylvania State University prohibits discrimination and harassment against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Direct all inquiries regarding the nondiscrimination policy to:

Affirmative Action Director
The Pennsylvania State University
201 Willard Building
University Park, Pa 16802-2801
Tel (814) 865-4700/V
(814) 863-1150/TTY.

PART III: ADMISSION TO PROGRAM AND INITIAL PROGRESSION

DEVELOPING A PLAN OF STUDY

All CEE graduate students are required to develop an *Advanced Degree Course Plan* for each of the M.Eng., M.S. and Ph.D. degrees early in the program, preferably by the end of the first semester (M.Eng. and M.S.) and no later than the end of the second semester of study (Ph.D.). In developing the Plan, students are assisted by their academic adviser. Doctoral students must submit an *Advanced Degree Course Plan* by or before their Candidacy Exam. In addition, doctoral students must specialize in a specific area within the field of civil and environmental engineering, develop in-depth understanding of research methods suitable to their area of specialization, and conduct an independent and original research study – the dissertation. Master’s and doctoral students are expected to develop a broad knowledge of the field of CEE, as well as a general knowledge of research designs and methods, demonstrating the suitability of designs and methods for the thesis or dissertation. Requirements for all the graduate degrees are specified in this handbook.

STUDENT ACADEMIC SUPPORT

Upon admission to the CEE graduate program, students are assigned an interim academic adviser by the program coordinator. The eventual adviser will be based on mutual career and research interests of the student and faculty. All academic advisers are full-time CEE faculty with Graduate Faculty status.

Adviser and student responsibilities

The academic adviser acts as the student’s primary academic and career mentor at Penn State. The adviser’s primary responsibilities are to: (1) assist in the development of an *Advanced Degree Course Plan*; (2) advise on and approve selection of course(s) each semester; (3) advise and assist on design and execution of research activities (M.S. and Ph.D.); (4) advise and assist in preparing the student for the candidacy and comprehensive examinations (Ph.D.); (5) assist with professional development activities (internships, attending and presenting at conferences, authorship of journal articles and conference proceedings, developing teaching portfolios, etc.) that would enhance academic preparedness and career prospects; and (6) serve as the chair (or co-chair) of the student’s committee (thesis for M.S.; dissertation for Ph.D.).

Communication between the graduate student, the adviser, and the thesis committee is a key factor in the progression through the graduate program. It is the student’s responsibility to consult with her/his adviser and committee regularly throughout the course of study. Contact may be made by telephone, e-mail, or in person by appointment.

CHANGING ADVISERS

A student may change her/his academic adviser. Either the student or the academic adviser may suggest this change. Proposed changes should be discussed between the affected parties prior to any official action. An adviser change must be made with the consent of the student, the new adviser, and the current adviser. Notification will need to be made to the Graduate Staff Assistant in the Academic Programs office, 216 Sackett.

SARI REQUIREMENTS

Since the Fall of 2009, all graduate students (M.Eng., M.S., and Ph.D.) must complete Scholarship and Research Integrity (SARI) training requirements. The SARI program at Penn State is designed to offer graduate students comprehensive, multilevel training in the responsible conduct of research (RCR) through a two-part program: (1) an online course to be completed in the first semester of graduate study, and (2) five hours of discussion-based RCR training prior to degree completion. Of the five hours of discussion-based RCR training, a maximum of two hours can be completed through Office of Research Protection (ORP) seminars and three hours are to be completed through College or Departmental seminars. All graduate students must register for CE 590 Colloquium (Fall semester only) to complete three-to-five hours of discussion-based RCR training through the Department.

SUPPORT SERVICES

The Commission for Adult Learners (CALs) provides assistance to adult students who wish to improve their skills in areas such as computers, math, and writing. Detailed information about CALs is located at: <http://cal.psu.edu/>

The Graduate & Professional Student Association (GPSA) provides graduate students with information on topics such as taxes and health care options, babysitters and typists/editors. Detailed information about GPSA is located at: <http://gpsa.psu.edu/about-the-gpsa/>

Penn State Human Resources provides services for students with a family. Descriptions of the programs offered are available at: <https://ohr.psu.edu/employee-and-family-resources>

The Gender Equity Center (GenEQ) supports students who have been impacted by sexual violence, relationship violence, stalking, harassment, and other campus climate issues. More information on the GenEQ is located at: <http://sites.psu.edu/genderequity/>

The Women in Engineering Program (WEP) actively promotes an equitable and productive academic environment in the College of Engineering. More information on WEP is located at: <http://psuengineeringdiversity.com/wep/>

Information pertaining to other student services are available on the Graduate School website: <http://bulletins.psu.edu/bulletins/whitebook/>

PART IV: GRADUATE SCHOOL DEGREE REQUIREMENTS

The Pennsylvania State University Graduate School publishes minimum requirements for all graduate degrees awarded by the University. Additional graduate degree requirements are established by the College of Engineering, the Department of Civil and Environmental Engineering, and programs within CEE. Graduate School graduate degree requirements are published on the Graduate School website in the Graduate Degree Bulletin at:

<http://www.psu.edu/bulletins/whitebook/>

The published Bulletin contains comprehensive Penn State University Graduate School requirements that must be met by M.Eng., M.S., and Ph.D. students to complete the respective degree. It is the responsibility of the student to read, understand, and discuss these requirements with her/his academic adviser, and if applicable, thesis adviser. The Penn State University Graduate School graduate degree requirements supersede any conflicting requirements.

In summary, the Penn State University Graduate School requirements address issues related to the following:

M.Eng. & M.S. specific requirements:

- minimum grade-point average required for graduation
- maintaining good academic standing
- M.Eng. time limitation
- M.S. time limitation
- advanced standing and transfer credits

Ph.D. specific requirements:

- general requirements
- time limitation to complete the program
- off campus and transfer credit
- advisers and doctoral committees
- English competency
- candidacy, comprehensive, and final examination
- thesis acceptance
- residence requirements
- continuous registration requirements

SARI (Scholarship and Research Integrity) requirements

- Online CITI Exam (completed the first semester of study)
- 5 hours of seminars (maximum of 2 hrs of ORP seminars; remaining hrs from CE 590 and College of Engineering seminars)

The above summary is not exhaustive and does not include Departmental and program requirements that may be in addition to the Graduate School requirements. All graduate students in the Department of Civil and Environmental Engineering are strongly encouraged to familiarize themselves with all Graduate School degree requirements.

PART V: MASTER OF ENGINEERING REQUIREMENTS

The following policies and procedures have been adopted by the Department of Civil and Environmental Engineering to supplement the *Procedures and Regulations* contained in the *Graduate Degree Programs Bulletin*. These requirements apply to all Master of Engineering (M. Eng.) degree candidates in the fields of Civil Engineering and Environmental Engineering.

DEGREE DESCRIPTION AND CREDIT REQUIREMENTS

The M.Eng. degree is a non-thesis professional master's degree. The program provides training for advanced professional practice. A minimum of 31 graduate credits (400 level and above) of course work are required. At least 18 credits must be earned in graduate courses (500 level and above) and at least 12 credits must be earned in courses with the CE prefix. A minimum of 20 credits must be earned at an established campus of the University. All students are required to take CE 535 Integrated Project Management for Civil Engineering (Spring only) to fulfill the requirement for a culminating experience. Students are allowed to take up to 3 credits of CE 596 Independent Study. All students are required to take the 1-credit CE 590 Colloquium (Fall only) and complete all requirements for Scholarship and Research Integrity (SARI) training.

The M.Eng. degree is designed as a one-year Master's degree program and students are required to start their degree in the Fall semester. The preferred plan of study is as follows:

- Fall semester: 12-15 credits of course work plus one credit of CE 590 (note that special permission is required to register for >15 credits)
- Spring semester: 12-15 credits of course work, including CE 535 (3 credits)
- Summer semester: 0-6 credits of course work

AREAS OF SPECIALIZATION FOR M.ENG. IN CIVIL ENGINEERING

All students entering the M.Eng. degree in Civil Engineering must select an area of specialization where each area has specific core course requirements (Table V.1). This area of specialization must be declared on the *Advanced Degree Course Plan*. The three areas of specialization are Infrastructure, Transportation Systems, and Water and Environment.

M.ENG. IN ENVIRONMENTAL ENGINEERING

The M.Eng. degree in Environmental Engineering has no further area of specialization. Core course requirements for all M.Eng. Environmental Engineering students are presented in Table V.2

CONTINUOUS REGISTRATION

The M.Eng. degree is designed as a one-year Master's degree program and students are required to start their degree in the Fall semester. Applicants admitted to the Civil or Environmental Engineering graduate programs must maintain continuous registration by registering for at least one credit each semester from the date of admission until all degree requirements have been satisfied. Students utilizing the resources of the University (i.e., faculty, facilities, etc.) during the summer must also register for the summer session. Degree requirements are only satisfied when the student has completed the required course work.

Table V.1. Core course requirements for areas of specialization for the M.Eng. in Civil Engineering.

	Infrastructure	Transportation Systems	Water and Environment
Core Required Courses	Complete 3 of 6: CE 512 Advanced Soil Mechanics CE 544 Design of Reinforced Concrete Structures CE 548 Structural Design for Dynamic Loads CE 582 Pavement Design and Analysis CE 584 Concrete Materials and Properties CE 597x Transportation Infrastructure Asset Management	Complete 3 of 4: CE 525 Transportation Operations CE 597 Public Transportation Systems CE 597 Human Factors CE 597 Traffic Operations on Highways and Urban Networks	Complete 2 of 3: CE 555 Groundwater Hydrology CE 561 Surface Hydrology CE 570 Environmental Aquatic Chemistry
Additional Required Courses	CE 535 Integrated Project Management for Civil Engineers CE 590 Colloquium	CE 535 Integrated Project Management for Civil Engineers CE 590 Colloquium	CE 535 Integrated Project Management for Civil Engineers CE 590 Colloquium
Elective Courses	several from C E, E MCH, and STAT	several from C E, I E, and STAT	several from C E, GEOSC, MATH, and METEO

Table V.2. Core course requirements for the M.Eng. in Environmental Engineering.

Core Required Courses	Complete 3 of 6: CE 479 Environmental Microbiology CE 570 Environmental Aquatic Chemistry CE 571 Physical-Chemical Treatment Processes CE 572 Biological Treatment Processes CE 573 Environmental Organic Chemistry CE 576 Environmental Transport Processes
Additional Required Courses	CE 535 Integrated Project Management for Civil Engineers CE 590 Colloquium
Elective Courses	several from C E, GEOSC, SOILS, EME

ADVISER/ADVANCED DEGREE COURSE PLAN

The general guidance of an M.Eng. degree candidate is the responsibility of the adviser who will be recommended by the program coordinator. The adviser will assist the student in planning a plan of study. An *Advanced Degree Course Plan* should be approved by the student's academic adviser and the Graduate Officer during the first four weeks of enrollment in the program. The *Advanced Degree Course Plan* must be completed by the end of the first semester.

TIME SCHEDULE

Upon admission:	Confer with the respective program coordinator, who will recommend an adviser to formulate a plan of study.
No later than the end of the first semester:	Submit proposed <i>Advanced Degree Course Plan</i> for approval by the academic adviser and the Graduate Officer.
First semester of study	Complete CE 590 and CITI online exam for SARI requirements
Final Certification:	Students who have completed all of the requirements for the degree will be approved for graduation.

PART VI: MASTER OF SCIENCE REQUIREMENTS

The following policies and procedures have been adopted by the Department of Civil and Environmental Engineering to supplement the *Procedures and Regulations* contained in the *Graduate Degree Programs Bulletin*. These requirements apply to all Master of Science (M.S.) degree candidates in the fields of Civil Engineering and Environmental Engineering.

DEGREE DESCRIPTION AND CREDIT REQUIREMENTS

The M.S. degree program is strongly oriented toward research. A thesis is required, and at least 6 credits of thesis research (C E 600 or 610) must be included in the candidate's academic course plan. A minimum of 31 graduate credits (400-level and above) are required, of which 20 must be earned at an established campus of the University. A minimum of 24 credits of course work are required, with at least 12 credits of course work (400 and 500 level) completed within the major (i.e., with C E courses prefixes). At least 18 credits must be included in the program at the 500 and 600 levels, combined. Specific core courses are required depending on the specialization within the department. Students are not permitted to count audited credits toward the minimum credits required for the degree. All students are also required to take the 1-credit CE 590 Colloquium (Fall only) and complete all requirements for Scholarship and Research Integrity (SARI) training.

Course work taken outside the major program area of emphasis can be used to satisfy the minimum of 6 credits in a minor or general study. A minor program must meet the approval of the departments or committees responsible for both the major and minor fields. Completion of a graduate minor is not a requirement for the M.S. degree.

The M.S. thesis should explore new ideas and techniques. Thus, the research topic is expected to investigate as yet unexplored areas of engineering, to extend the knowledge available, and advance the level of understanding of a relevant issue. Emphasis should be placed on the generalization of research findings and overall transferability to engineering problems.

M.S. IN CIVIL ENGINEERING

All students entering the M.S. degree in Civil Engineering must select and declare a program area aligned with their research interests. The four program areas are Geotechnical and Materials Engineering, Structural Engineering and Mechanics, Transportation Engineering, and Water Resources Engineering. Each program area has specific core course requirements (Tables VI.1 to VI.4).

Table VI.1. Core course requirements for the M.S. in Civil Engineering in the Geotechnical and Materials Engineering program. All students must take a minimum of one course associated with their topic area.

Topic	Course Options
Geotechnical Engineering	CE 511 Engineering Characteristics of Soils; or CE 512 Advanced Soil Mechanics; or CE 513 Advanced Foundation Engineering
Pavement Engineering	CE 582 Pavement Design and Analysis; or CE 597x Transportation Infrastructure Asset Management
Materials Engineering	CE 583 Bituminous Materials and Mixtures; or CE 584 Concrete Materials and Properties
Experimental Testing	CE 597x Experimental Methods in Geotechnical and Materials Engineering

Table VI.2. Core course requirements for the M.S. in Civil Engineering in the Structural Engineering and Mechanics program. All students must take, at a minimum, 3 of the 6 courses listed below with at least one course each from the Analysis and Design topics.

Topic	Course Options
Structural Analysis	CE 597x Nonlinear Structural Analysis; or CE 541 Structural Analysis; or CE 548 Structural Design for Dynamic Loads
Structural Design	CE 543 Prestressed Concrete Behavior and Design; or CE 544 Design of Reinforced Concrete Structures; or CE 545 Metal Structures Behavior and Design

Table VI.3. Core course requirements for the M.S. in Civil Engineering in the Transportation Engineering program. All students are expected to take a minimum of one course associated with each topic area; however, exceptions can be discussed with each student’s academic adviser.

Topic	Course Options
Operations	CE 525 Transportation Operations
Safety	CE 528 Transportation Safety Analysis
Design	CE 526 Highway and Street Design; or CE 527 Roadside Design and Management; or CE 421W Transportation Design

Table VI.4. Core course requirements for the M.S. in Civil Engineering in the Water Resources Engineering program. All students must take a minimum of one course associated with each topic area.

Topic	Course Options
Hydraulics	CE 462 Open Channel Hydraulic; or CE 564 Sediment Transport in Alluvial Streams; or CE 567 River Engineering
Hydrology	C E 555 Groundwater Hydrology; or C E 561 Fundamentals of Surface Hydrology

M.S. IN ENVIRONMENTAL ENGINEERING

All students entering the M.S. degree in Environmental Engineering must develop a plan of study that satisfies the core course requirements listed in Table VI.5 and prepares the student for their research activities. Students are encouraged to take courses outside of the environmental engineering specialty. Courses in hydrology, geochemistry, agronomy, chemical engineering, chemistry, biotechnology, mineral processing, and materials science are of particular interest. The plan of study should be developed in consultation with the student’s thesis adviser.

Table VI.5. Core course requirements for the M.S. in Environmental Engineering. All students must take a minimum of one course associated with each topic area.

Topic	Course Options
Biology	CE 479 Environmental Microbiology
Chemistry	CE 570 Environmental Aquatic Chemistry; or CE 573 Environmental Organic Chemistry
Chemical Transport	CE 574 Transport Processes in Porous Media; or CE 576 Environmental Transport Processes
Process Engineering	CE 571 Physical-Chemical Treatment Processes; or CE 572 Biological Treatment Processes

CONTINUOUS REGISTRATION

The M.S. degree is designed to be completed in four semesters, although it is possible to finish sooner. Applicants admitted to the Civil or Environmental Engineering graduate programs must maintain continuous registration by registering for at least one credit each semester from the date of admission until all degree requirements have been satisfied. Degree requirements have been satisfied when the student has completed the required course work and the M.S. thesis has been approved by the adviser, the thesis committee, and the Department Head. Students accessing the resources of the University during the summer must also register for the summer session.

ACADEMIC ADVISER/ADVANCED DEGREE COURSE PLAN

The general guidance of a M.S. degree candidate is the responsibility of the academic adviser through mutual agreement with the student. The adviser's role is to assist the student in planning a plan of study. An *Advanced Degree Course Plan* should be approved by the student's academic adviser and the Graduate Officer during the first 4 weeks of enrollment in the program. The *Advanced Degree Course Plan* must be completed by the end of the first semester.

SELECTION OF THESIS SUPERVISOR

The academic adviser will normally also serve as the thesis supervisor. However, upon mutual agreement between the academic adviser and the student, another graduate faculty member may be appointed to supervise the candidate's thesis, preferably before the start of the second semester. The thesis supervisor will recommend coursework supporting the research program, oversee the conduct of the research program and supervise the development of the master's thesis.

THESIS REQUIREMENTS

Students must follow the *Thesis and Dissertation Guide* for the development and formatting of the master thesis, which can be obtained at: <http://gradschool.psu.edu/current-students/etd/>. This publication contains information regarding format, paper, illustrations, etc.

Students who have activated their intent to graduate must submit a draft (no signatures required) of their thesis to the Graduate School Thesis Office by the published thesis format review deadline. Candidates whose theses have been approved by the Department must provide one signed, unbound copy to the Thesis Office by the published thesis final submission deadline. A final copy of the thesis must also be provided to the adviser and committee members as requested upon completion of the program.

ADVISORY COMMITTEE/THESIS PROPOSAL

When the student is ready to begin working on the thesis, an advisory committee must be appointed by the Graduate Officer in consultation with the student's adviser. Normally the advisory committee is appointed near the end of the first semester of study. The advisory committee consists of a minimum of three members of the graduate faculty, including the candidate's adviser and thesis supervisor. When appropriate, one of the committee members may be from outside the Department of Civil and Environmental Engineering. The student's thesis supervisor chairs the advisory committee. The Graduate Academic Programs Office must be notified as soon as the committee is formed so that committee members can be officially recorded and notified.

The advisory committee is responsible for:

- (a) approving the thesis topic,
- (b) monitoring the research progress,
- (c) reviewing the final draft of the thesis prior to the oral examination, and
- (d) conducting the oral examination of the candidate.

The official initiation of the thesis and research should begin with a proposal meeting that includes the advisory committee and the candidate. The proposal meeting should include a discussion of the research topic, research plan, and anticipated results of the research to allow a determination of the research program suitability.

FINAL THESIS APPROVAL

The final thesis must meet the approval of the Department Head, in whom the Graduate Faculty of the department has vested the responsibility to ensure that all theses conform to established standards and that the thesis supervisor and advisory committee have fulfilled all obligations with regard to the thesis. In addition, the thesis must be approved by the Graduate School Thesis Office.

Every M.S. degree candidate must undergo a public oral examination before the advisory committee. The candidate is responsible for scheduling the examination (date, time, and place) and informing the Graduate Academic Programs Office staff of the arrangements, as well as the title of the thesis. A notice announcing the defense will be posted for all faculty, graduate students, and interested members of the public. The candidate is expected to summarize the research in a presentation that will include:

- (a) a statement of the problem,
- (b) the motivation and justification for the research (i.e., relative importance of the subject to the profession),
- (c) a statement of research objectives,
- (d) a distinction between the contribution that originates from the candidate and that which has been taken from other sources,
- (e) a concise presentation of the research methodologies,
- (f) a presentation of key research results,
- (g) interpretation of the results, and
- (h) conclusions that are based on the research findings.

The candidate should expect to defend the research at the conclusion of the presentation and should be prepared to defend any portion of the thesis. Typically there will be a period of questioning open to the general public followed by a closed meeting with the advisory committee.

Time Schedule

Upon admission:	Confer with the respective program coordinator, who will recommend an adviser to formulate a plan of study.
No later than the end of the first semester:	Submit proposed <i>Advanced Degree Course Plan</i> for approval by the academic adviser and the Graduate Officer.
No later than the tenth week of the second semester:	Appointment of advisory committee and approval of thesis proposal.
During published period:	Activate intent to graduate on LionPATH
By published thesis format review deadline:	Submit a complete draft (no signatures required) to the Graduate School Thesis Office (115 Kern Building).
Two weeks prior to the thesis defense:	Provide a copy of the final draft to each advisory committee member.
Not less than two weeks following submission of the final draft:	Oral examination (thesis defense).
By published thesis final submission deadline:	Submit final, corrected, signed copy of thesis to the Thesis Office. In addition, copies must also be provided to the thesis adviser and committee members as requested.
Final Certification:	Students who have completed all of the requirements for the degree will be approved for graduation.

PART VII: DOCTORAL REQUIREMENTS

The following policies and procedures have been adopted by the Department of Civil and Environmental Engineering to supplement the *Procedures and Regulations* contained in the *Graduate Degree Programs Bulletin* <http://bulletins.psu.edu/graduate/degreerequirements/>. These requirements apply to all Doctor of Philosophy (Ph.D.) degree candidates in the fields of Civil Engineering and Environmental Engineering.

DEGREE DESCRIPTION AND CREDIT REQUIREMENTS

The Ph.D. is the highest degree offered by the Department and is designed to conduct the most advanced research in an area of specialization. A dissertation is required, and at least 12 credits of thesis research (CE 600, 601, 610 or 611) must be included in the candidate's academic course plan. All students in the Direct Entry program (i.e., without first completing a M.Eng. or M.S. degree) should complete at least 24 to 45 credits of coursework (400 and 500 level; total depends on area of specialization) beyond the B.S. degree, including all core course requirements for their area of specialization (Tables VI.1 – VI.5). Students are not permitted to count audited credits toward the minimum credits required for the degree. All students are required to take the 1-credit CE 590 Colloquium (Fall only) and complete all requirements for Scholarship and Research Integrity (SARI) training (only once). Prior to completion of the Ph.D. program, the candidate must spend at least two consecutive semesters as a registered full-time student.

The Ph.D. degree program is normally completed in four years by full-time students. However, time to complete the degree varies depending on individual effort and success in research and writing. The doctoral degree program typically consists of six stages: 1) core course work; 2) course work related to an area of specialization; 3) candidacy and English competency examinations; 4) naming of the doctoral committee and the comprehensive examinations; 5) research activities; and 6) writing and defending the doctoral dissertation.

PH.D. IN CIVIL ENGINEERING

All students entering the Ph.D. degree in Civil Engineering must select and declare a program area aligned with their research interests. The four program areas are Geotechnical and Materials Engineering, Structural Engineering and Mechanics, Transportation Engineering, and Water Resources Engineering. In Civil Engineering, Ph.D. coursework requirements beyond the Master's degree are typically finalized after the Ph.D. candidacy exam. In Structural Engineering and Mechanics, a minimum of 15 credits of graduate course work (400 level and above) is suggested beyond the Master's degree or beyond the 24 suggested credits for those in the Direct Entry program (i.e., 39 total credits of graduate coursework).

PH.D. IN ENVIRONMENTAL ENGINEERING

In Environmental Engineering, a minimum of 21 credits of graduate course work (400 level and above) is suggested beyond the Master's degree or beyond the 24 suggested credits for those in the Direct Entry program (i.e., 45 total credits of graduate coursework). For Ph.D. candidates who have completed a Master's degree in Environmental Engineering at Penn State, a minimum of 15 credits of graduate course work (400 level and above) is suggested.

CANDIDACY EXAMINATIONS

Official status as a doctoral student is granted when the candidacy examination has been passed. The candidacy examination serves three purposes: 1) to determine the compatibility between the student's academic and professional aspirations and the graduate program goals; 2) to assess the student's competence in areas critical to completion of the dissertation, including communication skills of writing, critical thinking, and conduct of research; 3) to confirm that the student should continue in the CEE Ph.D. program; and, 4) to finalize and approve

the Ph.D. *Advanced Degree Course Plan*. If the student is seeking dual candidacy in an approved dual-title graduate degree program, the dual-title field must be integrated into the candidacy examination of the student's major program (i.e., a single candidacy examination is administered, which incorporates both the graduate major field and the dual-title field).

The candidacy examinations should be taken during the second semester of study, however, must be taken within three semesters (excluding summer sessions) of entry into the doctoral program. Candidacy examination requests must be formally submitted to the Graduate Academic Programs Office no less than three weeks prior to the scheduled examination. The CEE Academic Programs Office will submit the examination results to the Graduate School for approval and recording. To be eligible for the candidacy examination, the student must meet the following criteria:

1. have a minimum grade-point average of 3.00 at the time the examination is given, for graduate work done at Penn State.
2. have no deferred grades, missing grades, or exceed 12 quality graded research credits.
3. have completed at least 18 credits beyond the bachelor of science.
4. be registered during the semester the examinations are administered, including summer.

The candidacy committee is appointed by the Area Coordinator upon recommendation of the academic adviser, who serves as chair of the candidacy committee. The committee consists of at least four members of the Graduate Faculty, including at least three members from the candidate's major program area.

Written English Candidacy Examination

The written English candidacy examination is administered and evaluated by the candidacy committee. The English examination consists of a candidate response in the form of a concisely written 3-to 5-page essay (600 to 1000 words) on a topic selected by the committee. The written English examination is typically administered no more than two weeks prior to the written candidacy examination. The examination is evaluated on the basis of syntax, grammar, spelling, and organization. If the candidate is unable to meet committee expectations for written English, one appeal for re-examination may be honored at the discretion of the candidacy committee.

Students who fail the written English candidacy examination must complete an English writing course, such as ENGL 202C (Effective Writing: Technical Writing). International students may schedule ESL 116G (ESL Composition for Academic Disciplines). A grade of "B" or better must be achieved for the candidate to satisfy the written English requirement. Candidates are permitted to complete remedial English writing courses a maximum of two times.

Written Candidacy Examination

The written candidacy examination is designed to test the candidate's retained knowledge from previous and current course work. The chair of the candidacy committee will solicit examination questions from each of the candidacy committee members covering specific areas of competence. The committee will determine the final composition of the written candidacy exam in cooperation with the committee chair. The candidate must successfully complete the written candidacy in order to continue to the oral candidacy examination. The oral candidacy examination is typically conducted within 2 weeks after the written candidacy examination.

Oral Candidacy Examination

The oral candidacy examination consists of a short oral presentation by the candidate followed by committee questions related to the presentation and the written candidacy examination. The oral candidacy examination will normally be 2 hours in length. The oral presentation duration is normally 10-15 minutes in the style of a conference presentation. The topic is determined by the candidate in consultation with the adviser. Committee evaluation of the presentation is conducted on the basis of organizational structure, delivery, and use of visual aids. The oral examination will continue with committee questions on the subject of the oral presentation. The primary focus of committee questions following the oral examination will be the subject material of the written candidacy examination and other important areas of required competence.

The candidacy committee may require candidates to enroll in ESL 114G (American Oral English for Academic Purposes) to improve speaking competency and achieve a grade of “B” or better. Candidates may take remedial speaking courses a maximum of two times to meet this requirement.

Candidacy Examination Results

The candidacy committee will meet to formulate a final, overall candidacy performance decision within one week of the oral candidacy examination. A favorable vote of at least two-thirds of the committee is required for passing both the oral and written components of the English and candidacy examinations. The committee may require the candidate to schedule courses to remediate academic and language deficiencies that were discovered during the candidacy examinations. Immediately following the candidacy committee meeting, the committee will meet with the candidate to discuss the results. The results will take the form of one of the three following:

1. Admit student to candidacy for the Ph.D. degree. From this point on the student will take the coursework outlined in the *PhD Advanced Degree Course Plan*, as amended by the candidacy committee and begin preparing for the comprehensive examination. This is the date set to begin the eight year time limitation to complete the PhD degree.
2. Postpone a candidacy decision until further conditions are met. These conditions may include additional technical course work or remedial writing or speaking course work as described under the written English and oral candidacy examinations above. The program committee will set forth all further conditions in writing to the candidate and file them with the Graduate Academic Programs office.
3. Do not admit student to candidacy. If this option is selected, alternative steps that may help the student achieve her/his academic and professional goals will be discussed prior to adjournment. If the candidate fails the oral candidacy examination, one appeal for re-examination may be honored at the discretion of the candidacy committee.

The chair of the candidacy committee shall forward the decisions, using the departmental grading form and the Graduate School “Report on Doctoral Candidacy” form to the Academic Programs office, 216 Sackett. The student becomes an official doctoral candidate only when positive candidacy examination results are recorded by the Graduate School.

DOCTORAL COMMITTEE AND COMPREHENSIVE EXAMINATION

This stage begins with the formation of a doctoral committee and culminates with a comprehensive examination. Following successful completion of the candidacy examinations and formation of the doctoral committee, the candidate conducts an in-depth exploration of a chosen area of study. During this stage, the candidate sharpens the subject and focus of the research undertaking, and develops theoretical frameworks/perspectives, and research methods and techniques suitable for studying a wide range of problems associated with the area of specialization. This is a highly individualized phase with candidates pursuing interests that are representative of faculty expertise, of the broader field of engineering, and with the potential for original contribution to the scientific area of inquiry.

The Doctoral Committee

The candidate should carefully select a doctoral committee as soon as possible, but no more than six months after successfully completing the candidacy examinations. Upon notification from candidate's academic adviser, the Department Head will recommend the candidate's doctoral committee to the Graduate School. Upon approval of the doctoral committee by the Graduate School, the committee will be recorded. The chair of the doctoral committee is also the student's permanent academic and thesis adviser and will, along with the doctoral committee, provide overall guidance for the candidate's doctoral program. The committee will direct the candidate in the preparation of the research proposal, conduct of the research, and the development and defense of the thesis. Doctoral committee members should bring different but complementary strengths to the candidate's research program. The candidate is advised to choose individuals who can provide expertise in the chosen area(s) of specialization, the general field of engineering, and the research methods specific to the dissertation.

Establishing the Doctoral Committee

The doctoral committee consists of four or more active members of the Graduate Faculty. In addition, the Doctoral Committee satisfies the following guidelines:

- at least two members are from the CEE Department; at least one is from the campus at which the student is enrolled
- the dissertation adviser usually serves as chair
- if the candidate is also pursuing a dual-title field of study, a co-chair representing the dual-title field must be appointed (in most cases this would also be the dissertation adviser)
- at least one member must represent a field outside the candidate's major field of study. This member is referred to as the "Outside Field Member." A dual-title representative may serve as the Outside Field Member.
- at least one member must be in an administrative unit from outside CEE Department. This member is referred to as the "Outside Unit Member."
- if applicable, the "Outside Field Member" and the "Outside Unit Member" may be one person.
- if the candidate has a minor, that field must be represented on the committee by a "Minor Field Member."

Students should formally request a doctoral committee appointment from the CEE Graduate Programs Office within six months of passing the candidacy examinations. The doctoral committee request is then forwarded by the Graduate Academic Programs office to the Graduate School for approval and recording. Additional specific doctoral committee composition requirements are presented in the *Graduate Degree Programs Bulletin*.

Committee Responsibilities

The appointment of a doctoral committee constitutes a major shift in program orientation, requiring the candidate to consult regularly with at least three faculty advisers. The doctoral committee approves the graduate study plan, periodically reviews academic progress, advises the student on her/his area of specialization, guides the student's dissertation research, prepares and administers the comprehensive and final oral examination (the dissertation defense), and evaluates the student's doctoral dissertation. Continuing communication between the student and her/his doctoral committee members is strongly recommended so as to allow a mentoring process to develop and to preclude misunderstandings during the final stages of study.

Thesis Adviser

The candidate must designate a thesis adviser, normally the doctoral committee chair or co-chair serve as thesis adviser(s). The thesis adviser directs the student's dissertation research. As such, she/he must specialize in the area of the chosen thesis.

Replacing committee members

A student may replace any or all members of the doctoral committee. To make committee changes, the student must complete a new *Doctoral Committee Appointment Signature Form*, have it signed by the new committee member(s), and submit it to the Graduate Academic Programs office who will forward it to the Graduate School. Either the student or the incumbent (committee member) may suggest a replacement, however, all affected parties should meet and agree prior to formal action. The student must consult with her/his committee chair before replacing a committee member.

It is the responsibility of the Professor-in-Charge to periodically review the membership of doctoral committees to ensure that its members continue to qualify for service on the committee in their designated roles. For example, if budgetary appointments or employment at the University have changed since initial appointment to the committee, then changes to the committee membership may be necessary.

Comprehensive Examination

Upon the recommendation of the thesis adviser, the candidate should begin registering for thesis research when formal drafting of the dissertation proposal has begun. Ph.D. students are required to register continuously for Thesis Preparation (CE 601) from the time they begin formally writing their proposal until the Thesis is successfully defended. Thesis preparation (CE 601) carries no credits. No more than 12 research credits may receive a grade other than an "R".

Preparation of the Thesis Proposal

A formal, written proposal detailing the proposed doctoral research must be developed independently by the candidate. The research proposal serves as the first formal step in the thesis research. It documents a personalized plan for conducting the study, and, in addition, serves as a contract between the student and the doctoral committee regarding what is expected in the ensuing research. Led by the thesis adviser, the doctoral committee supervises the development of the student's proposal, conducts the proposal hearing and approves the proposal. Regular consultation with committee members is strongly encouraged. The research proposal must be submitted to the doctoral committee at least two weeks prior to the Oral Comprehensive Examination.

The typical research proposal includes:

1. a brief topic background, research motivation, and a concise statement of the problem;
2. a clear articulation of research objectives and a defined research scope;
3. a literature review to justify the research problem and establish the state-of-the-art;
4. a work plan, including scheme for data collection, data analysis, and hypothesis testing;
5. preliminary results;
6. anticipated results and expected presentation methods;
7. engineering significance;
8. chart showing the key activities and time schedule; and
9. references critical to the research.

The purpose of the oral comprehensive examination is to evaluate the candidate's competence and potential for conducting independent research. The candidate is expected to demonstrate competence consistent with the candidate's intended thesis research. The candidate is encouraged to discuss with individual doctoral committee members the material upon which the candidate will be examined. The Graduate Academic Programs Office must be notified a minimum of three weeks in advance of the Oral Comprehensive Examination so that Graduate School notification and approval can be completed.

The candidate will orally present and defend the research proposal as part of the oral comprehensive examination. The research proposal will be evaluated by the doctoral committee based on technical merit and other criteria deemed critical to the research by the doctoral committee. Approval of the proposal must have at least two-thirds favorable vote from the committee.

To be eligible for the comprehensive examination, the candidate must meet the following criteria:

1. complete all core courses, and other requirements as determined by the doctoral committee;
2. achieve a minimum graduate coursework grade-point average of 3.00;
3. have no deferred or missing grades;
4. satisfy the English Competence requirement; and
5. be registered as a full-time or part-time student for the semester in which the examination is taken.

Students who have passed the oral comprehensive examination can maintain continuous registration by registering for credits in the usual manner or by enrolling for noncredit CE 601 (full-time thesis preparation) or 611 (part-time thesis preparation).

Continuous Registration and Satisfactory Scholarship

Degree candidates must maintain continuous registration (normally excepting summers) from the date of admission until all degree requirements have been satisfied. Candidates who do not maintain continuous registration may be dropped from the program and must apply for a resumption of study.

Research credits (CE 600 or CE 610) should reflect the time and effort spent in the laboratory, analyzing data, writing the thesis, or other activities specific to the thesis. Each candidate may receive up to 12 credits of quality grades ("A" through "F") for CE 600 or CE 610 activities. Advisers may also report an "R" (Research) grade for CE 600 and CE 610. All quality graded research credits beyond an accumulated 12 must be evaluated with an "R".

Satisfactory scholarship and acceptable progress toward the doctoral degree is required for continuance in the program. One or more failing grades or a cumulative grade-point average below 3.00 for any semester or session (or a combination thereof), may be considered as evidence of failure to maintain satisfactory scholarship.

CONDUCTING RESEARCH

Conducting research and writing a dissertation typically takes between two and three full years depending on the candidate's expertise and efforts, and the types of research methods employed. The candidate must accomplish the research according to the plan set forth in the proposal as presented to the doctoral committee. While conducting the research the candidate will be in regular communication with her/his thesis adviser and doctoral committee members. Major changes require approval of the doctoral committee.

WRITING AND DEFENDING THE DOCTORAL DISSERTATION

Writing Final Thesis Draft

The thesis adviser will ensure that the final draft includes all appropriate sections, is prepared according to an acceptable style, and is ready to be submitted to the doctoral committee. The candidate is responsible for the content and style. In addition, the candidate must follow the rules and deadlines of the Graduate School concerning thesis preparation which are detailed in the *Thesis and Dissertation Guide* at: <http://gradschool.psu.edu/current-students/etd/>.

Both the thesis adviser and the candidate are responsible for ensuring the completion of a draft of the thesis and for adequate consultation with members of the thesis committee well in advance of the oral examination. Major revisions to the thesis must be completed before the final oral examination. The thesis should be in its final draft, with appropriate notes, bibliography, tables, etc., at the time of the oral examination; both the content and style must be correct and polished by the time this final draft of the Thesis is in the hands of the committee.

Final Oral Examination Dissertation Defense

The final oral examination for CEE doctoral students is a public, oral examination administered and evaluated by the candidate's entire doctoral committee. The meeting is chaired by the student's doctoral committee chair. The final oral examination will consist of an oral presentation of the doctoral candidate's thesis and a public period of questions and candidate responses. Questions will normally relate directly to the thesis, but may cover the candidate's entire plan of study because the major purpose of the examination is also to assess the student's general scholarly attainments. The portion of the examination in which the thesis is presented is open to the public.

Scheduling the Final Oral Examination

The length of the final oral examination is normally 2 to 3 hours and may be scheduled any time during the semester. However, the examination may not be scheduled until at least 90 days have elapsed after the comprehensive examination was passed. The examination is officially scheduled by the Office of Graduate Enrollment Services, on the recommendation of the Professor-in-Charge of the CEE program. A formal request for the final oral examination must be received by the Graduate Academic Programs Office at least three weeks prior to the scheduled examination. The doctoral candidate is responsible for scheduling the examination.

To schedule the final oral examination the candidate must:

1. be registered and in good standing for the semester in which the final oral examination is taken;
2. ensure that at least 90 days have elapsed between passing the comprehensive examination and the proposed final oral examination date;
3. satisfy all other requirements for the degree;
4. gain thesis adviser approval of the thesis draft;
5. negotiate, with all doctoral committee members, a final oral examination date;
6. notify the Graduate Academic Programs office at least three weeks prior to the proposed examination date; and
7. Additional Graduate School requirements for the conduct of the final oral examination are presented at: <http://bulletins.psu.edu/graduate/degree/requirements/>

Final Oral Examination Results

Immediately following the oral examination the doctoral committee will meet to formally evaluate the candidate's work and cast votes. A favorable vote of at least two-thirds of the members of the committee is required to pass the final oral examination. If the student fails, it is the responsibility of the doctoral committee to determine whether a second final oral examination will be granted. A candidate may not be allowed more than two attempts at the final oral examination. The Graduate Academic Programs office will communicate the results to the Office of Graduate Enrollment Services.

FINAL DISSERTATION DOCUMENT

After passing the final oral examination, doctoral candidates must make the necessary corrections or revisions suggested by the committee members, and prepare the thesis in final form. Candidates must allow sufficient time to make revisions in order to meet the deadlines of the CEE program and the Graduate School. Candidates must present their final thesis to the Graduate Academic Programs office for signature no later than three weeks before the deadline set by the Graduate School.

Original signatures of all doctoral committee members must appear on the appropriate page in proper form when the thesis is presented to the Graduate Academic Programs office. Once signed, the student delivers the dissertation to the Thesis Office. In addition:

1. It is customary for the student to present a library-bound copy to the thesis adviser and committee members.
2. Follow the instructions from the Graduate School Thesis Office for the submission of one thesis copy to the Pattee Library.

GRADUATION

To graduate, students must activate your intent to graduate on LionPATH and payment of the thesis fee are necessary during the semester in which one wishes to graduate.