# MARYLAND HIGHER EDUCATION COMMMISSION
# ACADEMIC PROGRAM PROPOSAL

## PROPOSAL FOR:

____ NEW INSTRUCTIONAL PROGRAM

__✓__ SUBSTANTIAL EXPANSION/MAJOR MODIFICATION **(for online delivery)**

____ COOPERATIVE DEGREE PROGRAM

__✓__ WITHIN EXISTING RESOURCES or ____ REQUIRING NEW RESOURCES

*(For each proposed program, attach a separate cover page. For example, two cover pages would accompany a proposal for a degree program and a certificate program.)*

**Johns Hopkins University**
Institution Submitting Proposal

**Fall 2016**
Projected Implementation Date

| **Master of Civil Engineering (MCE)** | **Civil Engineering** |
|---|---|
| Award to be Offered | Title of Proposed Program |

| **0908-00** | **14.1801** |
|---|---|
| Suggested HEGIS Code | Suggested CIP Code |

| **Whiting School of Engineering** | **T.E. Schlesinger, Dean** |
|---|---|
| Department of Proposed Program | Name of Department Head |

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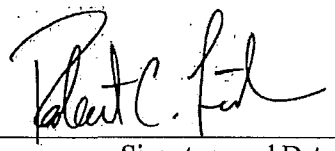

**3/1/2016**
Signature and Date

President/Chief Executive Approval

**n/a**
Date

Date Endorsed/Approved by Governing Board

**The Johns Hopkins University**
**Whiting School of Engineering**
**Proposal for Substantial Modification to an Existing Program**

**Master of Civil Engineering**

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## A. Centrality to institutional mission statement and planning priorities

### 1. Program description and alignment with mission

The Johns Hopkins University Whiting School of Engineering is pleased to submit a proposal to substantially modify its existing and previously endorsed Master of Civil Engineering (HEGIS code 0908-00, CIP code 14.0801) to offer an online option. The Master of Civil Engineering has been offered through the JHU Whiting School of Engineering's Engineering for Professionals (JHU-EP) division since 1984.

This online version of the Master of Civil Engineering program will provide students pursuing careers in civil engineering with a course of study that balances theory with practice, giving them the knowledge and skills necessary to enhance their effectiveness in a complex and rapidly evolving technological environment. Graduates will be prepared for specialized jobs involving all aspects of civil engineering including infrastructure components such as buildings, power plants, roadways, bridges, water supply systems, wastewater systems, and ocean and estuarine structures as well as the development of less traditional structures and systems, such as mechanical prostheses and space vehicles. To prepare the civil engineering workforce to meet the challenges they will face, the Master of Civil Engineering program offers a wide variety of graduate courses in the areas of coastal engineering, geotechnical engineering, and structural engineering.

The mission of The Johns Hopkins University is to educate its students and cultivate their capacity for life-long learning, to foster independent and original research, and to bring the benefits of discovery to the world. In addition, the mission of the JHU Whiting School of Engineering is to provide educational programs of the highest quality that will attract the most qualified and driven students and faculty and will be a world-recognized leader in engineering education, to lead in the creation and dissemination of knowledge, and to translate those educational and research activities into solutions to important societal problems. The proposed degree program aligns with both of these missions as discussed below.

### 2. Alignment with institutional strategic goals

One of the four strategic priorities of the JHU Whiting School of Engineering is to "Educate future leaders by providing students with an innovative and distinctive education of the highest quality, both at the undergraduate and graduate level, in a diverse and inclusive environment." One of the near-term goals within that priority is to develop a comprehensive suite of contemporary master's degree offerings, for full- and part-time students, with flexible formats that respond to the needs of industry in both the domestic

and international markets. It is clear that an online program offers a flexible format and enables this program to more easily reach the international markets cited in this goal.

The Johns Hopkins University professional programs in the fields of engineering and applied science are among the oldest and largest in the United States. Administered by the Whiting School of Engineering through JHU-EP, this activity seeks to meet the lifelong education needs of working professionals in engineering and applied science. JHU-EP offers state-of-the-art courses combined with the convenience, flexibility, and accessibility that make these educational opportunities feasible for working adults.

In recent years, JHU-EP has moved steadily into the field of distance education, offering more and more courses online. This development meets two needs: (1) it contributes to the convenience and flexibility of existing offerings, by allowing students to take a mix of classroom and online courses, and (2) it opens this educational opportunity to a much larger market, enabling students throughout the country and, indeed, the world to take courses at Johns Hopkins University.

The goal of this initiative is to promote and enhance the quality of education in civil engineering both nationwide and internationally through the utilization of advanced online educational technologies. The proposal is for the development of a fully online Master of Civil Engineering degree that will build and draw on the strengths of existing resources and the expert faculty within the Johns Hopkins University Whiting School of Engineering as well as the private and government sectors already involved in our classroom program. The program will provide professionals with in-depth knowledge and technical skills in the field of civil engineering and prepare students for technically significant careers within industry and governmental organizations.

## B. Adequacy of curriculum design and delivery to related learning outcomes

### 1. Program outline and requirements

A full course listing with course titles and descriptions is provided in Appendix A. All courses are three (3) credits.

**Admission Requirements**

General admission requirements for master's degree candidates and others seeking graduate status are as follows: applicants must be in the last semester of undergraduate study or hold a bachelor's degree from a regionally accredited college or university.

In addition, applicants must have a degree in Civil Engineering or an appropriate related field that provides the necessary preparation for graduate-level courses. All admissions decisions are made by the program committee on an individual basis.

## Degree Requirements

In order to earn a Master of Civil Engineering, a total of 10 courses (30 credits) approved by an advisor, must be completed within five years.

The Civil Engineering program consists of two parts: the program core of three courses (9 credits) and seven program electives (21 credits). All students are required to take one core course (3 credits) in mathematics (see Courses section below). For a student pursuing one of the focus areas (Geotechnical Engineering or Structural Engineering), the additional two core courses (6 credits) are indicated in the Courses section. For a student following a general Civil Engineering program, the additional two core courses (6 credits) are also outlined below. Seven program electives (21 credits) may be selected by the student, with the following requirements: For students pursuing one of the focus areas, a minimum of four electives (12 credits) must be selected from the appropriate list, and a minimum of six electives (18 credits) must be selected from Civil Engineering offerings or a closely related field. For students following a general Civil Engineering program, a minimum of six electives (18 credits) must be selected from Civil Engineering offerings or a closely related field. Up to two elective courses (6 credits) may be taken in research. Courses in the program must be at the 400 level or above. Unless prior approval is obtained from the program chair, at least five of the courses (15 credits) in the program must be at the 600 level or above.

## Focus Areas

The Master of Civil Engineering program allows students to develop a program that suits their professional needs. Students may choose to focus their studies in Geotechnical Engineering or Structural Engineering by selecting courses from one of those two established focus areas. The focus areas are presented as an aid to students in planning their course schedules; they do not appear as official designations on a student's transcript or diploma.

Alternatively, students who do not identify with either of those two disciplines may work with their advisors to select a broad yet cohesive group of courses to make up a general program of study.

## Required Courses

All students in the Civil Engineering program must complete one of the following Applied and Computational Mathematics courses:

535.441 Mathematical Methods for Engineers
615.441 Mathematical Methods for Physics and Engineering

**Courses by Focus Area**

Students who choose to focus their studies in Geotechnical Engineering or Structural Engineering should select two core courses and a minimum of four electives from the lists below. Required core courses in each focus area are denoted by an asterisk (*).

Geotechnical Engineering Focus Area

565.410 In Situ and Laboratory Testing Methods for Soil Construction
**565.475 Advanced Soil Mechanics***
**565.480 Earth Engineering***
565.625 Advanced Foundation Design
565.635 Ground Improvement Methods
565.640 Instrumentation in Structural and Geotechnical Engineering
565.645 Marine Geotechnical Engineering
565.715 Application of Numerical Methods in Geotechnical Engineering
565.742 Soil Dynamics and Geotechnical Earthquake Engineering
565.745 Retaining Structures and Slope Stability

Structural Engineering Focus Area

**565.415 Applied Finite Element Methods***
565.430 Design of Wood Structures
**565.600 Structural Mechanics***
565.605 Advanced Reinforced Concrete Design
565.620 Advanced Steel Design
565.630 Prestressed Concrete Design
565.640 Instrumentation in Structural and Geotechnical Engineering
565.650 Port and Harbor Engineering
565.670 Coastal Structures
565.752 Structural Dynamics
565.756 Earthquake Engineering I
565.758 Wind Engineering
565.766 Earthquake Engineering II
565.784 Bridge Design and Evaluation

Required Courses for Students with No Focus Area

565.475 Advanced Soil Mechanics

565.600 Structural Mechanics

**2. Educational objectives and student learning outcomes**

The educational objective of the online Civil Engineering program is to provide students pursuing careers in civil engineering with a course of study that balances theory with practice, giving them the knowledge and skills necessary to enhance their effectiveness in a complex and rapidly evolving technological and organizational environment. The

program is designed not only to broaden and strengthen students' understanding of the traditional fundamentals but also to introduce them to contemporary applications and technologies. Graduates will be prepared for specialized jobs involving all aspects of civil engineering based on material from two focus areas: geotechnical engineering and structural engineering.

The student learning outcomes for the Master of Civil Engineering program are as follows:

- Demonstrate an ability to identify, formulate, and solve complex problems in civil engineering
- Demonstrate an ability apply mathematics, science, and engineering principles
- Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice

**3. General education requirements**

Not applicable.

**4. Specialized accreditation/certification requirements**

Not applicable.

**5. Contract with another institution or non-collegiate organization**

Not applicable.

**C. Critical and compelling regional or statewide need as identified in the State Plan**

**1. Demand and need for program**

JHU-EP has offered the Master of Civil Engineering since 1984. Annual course enrollments have averaged 72 over the past five years. Students come from throughout Maryland and northern Virginia. The growth in the hiring of civil engineers by the government and the commercial sector in this region and nationwide has made the need for degree programs like this more apparent.

For busy working professionals, flexibility is very important, as is the ability to continue their education in the face of work demands. Online courses will create scheduling flexibility and increase course choices for students pursuing the onsite programs. They will also accommodate students who must leave the area due to military deployment or relocation by their employer. Online offerings will give JHU-EP the opportunity to retain students with frequent business travel or job assignment outside of this region as well as those with personal commitments requiring schedule flexibility.

In addition, the online Master of Civil Engineering will enable JHU to further spread its influence on the education and practice of civil engineering across the nation and around the world. The graduate program of the JHU Civil Engineering Department, with which

the JHU-EP program shares instructors, is ranked number 21 in the nation by US News and World Report.

For these reasons, JHU-EP identified a need for a fully online Master of Civil Engineering and committed to the development of such a program. The first online Civil Engineering course was offered in the summer term of 2014. Additional courses will be added each subsequent term to increase both the number of courses offered online as well the number of enrolled online students.

**2. Alignment with the 2013 Maryland State Plan for Postsecondary Education**

The proposed program is well aligned with *Maryland Ready,* the 2013–2017 Maryland State Plan for Postsecondary Education. The Master of Civil Engineering is intended to prepare highly trained scientists and engineers to work in organizations where they can contribute to the needs of society. The long-term success of JHU-EP programs for working professionals attests to the quality and effectiveness of these programs. This is consistent with the Goal 1 of the State Plan, "Quality and Effectiveness," which asserts that Maryland will enhance its array of postsecondary education programs to more effectively fulfill the evolving educational needs of its students, the state, and the nation.

Similarly, the proposed program is consistent with Goal 4, "Innovation," which articulates Maryland's aspiration to be "a national leader in the exploration, development, and implementation of creative and diverse education and training opportunities that will align with state goals, increase student engagement, and improve learning outcomes..." By leveraging technology in innovative ways to make JHU-EP offerings more accessible and interactive, candidates can pursue "anytime, anywhere" learning opportunities. Candidates can undertake course-related activities at a time and a location most convenient to them, allowing students to participate in and to complete their program even if their work schedules do not permit regular class attendance or if they move away from the Maryland region, thus also supporting Goal 2, "Access, Affordability, and Completion."

The proposed program is also consistent with Goal 5, "Economic Growth and Vitality," which is centered on supporting a knowledge-based economy through increased education and training. The proposed program will prepare highly qualified local scientists and engineers to contribute to the economic growth and vitality by providing life-long learning to scientists and engineers so they can maintain the skills they need to succeed in the workforce.

**D. Quantifiable and reliable evidence and documentation of market supply and demand in the region and State**

**1. Market demand**

According to the Bureau of Labor Statistics (BLS), "Employment of civil engineers is projected to grow 20 percent from 2012 to 2022, faster than the average for all occupations. Job prospects may be best for those who stay abreast of the most recent advances in technology." Pursuing a degree like this Master of Civil Engineering is a

significant way to maintain career viability. Job opportunities for the graduates of this program include positions in corporations and government organizations.

In addition to the national employment projections made by the Bureau of Labor Statistics noted above, the State of Maryland makes projections in a more detailed way. The Classification of Instructional Program (CIP) code for this proposed Master of Civil Engineering programs is 14.0801. The Standard Occupational Codes (SOC) associated with this CIP by the Bureau of Labor Statistics are: 11-9041 Architectural Engineering Managers; 17-2051 Civil Engineers; and 25- 1032 Engineering Teachers, Postsecondary. The Maryland Department of Labor Licensing and Regulation (DLLR) projects that long-term employment opportunities for these SOC codes will increase from 2012 to 2022 at an annual rate of 1.6% for Civil Engineers, 1.2% for Engineering Teachers Postsecondary. And 0.5% for Architectural Engineering Managers.

Since an online degree program like this proposed one will attract students from across the nation, the national employment projections are probably more relevant to the success of this program. Based on the projected market demand and the accessibility and convenience of an online program, we expect this degree program to be successful.

**2. Educational and training needs in the region**

The growth of enrollments in the existing Master of Civil Engineering over the past seven years is the strongest evidence that there is a solid and persistent demand for this degree program to serve the regional educational needs. Civil engineering is one of the core engineering disciplines and plays an important part in the engineering workforce in the region. The number of job openings in Maryland for civil engineers posted on major job clearinghouse web sites range from 15 to 20. There is no reason to expect the number of students seeking this Master of Civil Engineering to decrease in the foreseeable future.

**3. Prospective graduates**

The following table shows the number of graduates over the last five years from Maryland universities with master's degrees for programs with the CIP code of 14.0801. This data was found in the Maryland Higher Education Commission's graduation trend data base.

| Univ. | Degree | Field | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| UMBC | Masters | Environmental Engineering | 2 | 2 | 1 | 1 | 2 |
| UMCP | Masters | Civil Engineering | 30 | 35 | 39 | 43 | 36 |
| JHU | Masters | Civil Engineering | 11 | 16 | 12 | 13 | 29 |

## E. Reasonableness of program duplication

### 1. Similar programs

As noted above in Section D.3 there are two other master's level degree programs with the CIP code of 14.0801offered in the state of Maryland. The first, a master's degree in environmental engineering offered by the University of Maryland Baltimore County has virtually np overlap with this proposed degree program since environmental engineering topics are covered in three other specifically environmental engineering related degree programs offered by JHU-EP; the Master of Environmental Engineering, the Master of Science in Environmental Engineering and Science, and the Master of Science in Environmental Planning and management.

The second is the civil engineering program offered at the University of Maryland College Park. The University of Maryland Clark School of Engineering offers a Professional Master of Engineering (M.Eng.) in Civil and Environmental Engineering, administered by the Office of Advanced Engineering Education. This is a flexible educational program designed to advance technical knowledge and career opportunities for working professionals. All courses are available on-campus for full-time or part-time study and some courses are available via synchronous video teleconferencing at regional education sites throughout Maryland.

### 2. Program justification

There is no other civil engineering master's degree program offered asynchronously online in the State of Maryland. In view of the market demand for such a program, the JHU Master of Civil Engineering clearly meets a currently important need in the region.

## F. Relevance to Historically Black Institutions (HBIs)

### 1. Potential impact on implementation or maintenance of high-demand programs at HBIs

There are no known master's level programs like this JHU program in any of the Historically Black Institutions in Maryland.

### 2. Potential impact on the uniqueness and institutional identities and missions of HBIs

By definition, an appropriate student for the proposed Master of Civil Engineering would apply after attending and completing a baccalaureate degree at any undergraduate institution, including any of Maryland's Historically Black Institutions. The proposed program would not directly affect the implementation, maintenance, uniqueness, identity or mission of these institutions.

## G. Evidence of the Principles of Good Practice

See Appendix B for the evidence that this program complies with the Principles of Good Practice noted above.

The Higher Education Opportunity Act (HEOA) enacted in 2008 requires that an academic institution that offers distance education opportunities to students: 1) has a process established to verify that the student who registers is the same student who participates in and completes the offering and receives academic credit for it, 2) has a process established to verify that student privacy rights are protected, and 3) has a process established that notifies the student about any additional costs or charges that are associated with verification of student identity. In this graduate program, the following actions have been taken to satisfy these requirements: 1) students may only enter the academic website for the online courses they take by providing their unique student ID and password they receive when they are admitted to the programs, 2) all FERPA privacy rights are preserved by limiting access very specifically in the University student information system to only those permitted by law to have access to restricted student information, and 3) there are no additional costs assessed to the student for the measures we use to verify student identity.

## H. Adequacy of faculty resources

See Appendix C for a representative list of faculty who will teach in the proposed program. The program currently has 19 highly qualified faculty members. Each is a distinguished and experienced professional and all but six have earned Ph.D.'s in their field of expertise. Each has demonstrated a strong commitment to excellence in teaching. Faculty come from a number of universities and organizations, including the JHU Whiting School of Engineering, the US Naval Academy, and the National Institute of Standards and Technology, as well as several other local organizations and government agencies. Many hold influential positions in these organizations. Currently, four faculty members teach online courses. The JHU Engineering for Professionals program strives to provide engineering education rooted in practice, and for this, we rely heavily on the practitioner faculty members employed. While a majority of the faculty are part-time instructors, the strength of the program depends on the fact that they are full-time practitioners in their disciplines.

## I. Adequacy of library resources

Students have full and complete access to the Milton S. Eisenhower Library on the Homewood campus, which is ranked as one of the nation's foremost facilities for research and scholarship. Its collection of more than three million bound volumes, several million microfilms, and more than 13,000 journal subscriptions has been assembled to support the academic efforts of the University. The interlibrary loan department makes the research collection of the nation available to faculty and students. The library also provides easy access to a wide selection of electronic information resources, including the library's online catalog, and numerous electronic abstracting and indexing tools. Many of the databases are accessible remotely. Librarians help students electronically and the library maintains an extensive web site to take visitors through all of its services and materials. To this are added more than 10,000 audiovisual titles available for on-site consultation.

## J. Adequacy of physical facilities, infrastructure and instructional equipment

All courses in the proposed program will be offered online. The program will have no discernible impact on the use of existing facilities and equipment beyond the standard requirements already in place; primarily, faculty office space in an existing university facility location.

In terms of technology infrastructure and support, this program will be delivered via JHU-EP's online programs infrastructure, which includes the Blackboard course management system and the Adobe Connect video conferencing system. Both of these systems are supported by the Whiting School and the university's IT infrastructure. These systems provide password-protected online course sites and community management systems that enable ongoing collaborative exchange and provide convenient channels for synchronous and asynchronous learning. Blackboard is one of the world's leading providers of e-learning systems for higher education institutions. This software focuses on educational outcomes and provides a highly flexible learning environment for students. Johns Hopkins is also outfitted with suitable technical and professional staff and a 24/7 technical help desk to provide technical assistance to the students taking online courses. All of the student services such as application processes, course registration, bookstore, ID service, and advising are currently provided online as well.

The Whiting School already successfully delivers all of its online and web-enhanced courses and programs using the above mentioned platforms. As part of the program's development, the school's technical support team and business office have determined that JHU-EP possesses the necessary technology infrastructure and resources in place to support successful delivery of this online program

## K. Adequacy of financial resources with documentation

See Appendix D for detailed financial information.

## L. Adequacy of provisions for evaluation of program

Once the online Master of Civil Engineering program is launched, the program and courses will be evaluated using student surveys and program committee reviews on a regular basis. For example, feedback regarding the appropriateness of course content will be solicited from students every time a course is offered. The program committee will meet annually to assess course evaluations and other feedback provided by students, faculty and other stakeholders in the program. Based on these data, the program committee will implement changes to the program (in terms of curriculum content, course delivery mechanisms, etc.) as necessary.

## M. Consistency with the State's minority student achievement goals

Any student meeting the admissions requirements can apply to the Master of Civil Engineering. The program will work to help all accepted students improve their workplace competitiveness and reach their professional goals, an aim consistent with the State's minority student achievement goals.

**N. Relationship to low productivity programs identified by the Commission:**

Not applicable.

## Appendix A

## Course Descriptions

**565.410 *In Situ* and Laboratory Testing Methods for Soil Construction (3)**
The course covers selection of field and laboratory testing of soils based on site conditions, project specificities, and expected soil response to project loads. *In situ* field testing includes standard penetration test, cone penetrometer test, pressuremeter, dilatometer, and vane shear. Laboratory tests of soil include soil characterization, direct shear, triaxial compression (static and cyclic), consolidation, and advanced testing. The course covers development of a geotechnical investigation plan, including field exploration and laboratory testing to support the design and analysis of soil constructions. *In situ* geotechnical monitoring instrumentation, data acquisition, and management are covered.
*Prerequisites:* 560.305 Soil Mechanics or equivalent.

**565.415 Applied Finite Element Methods (3)**
This course will introduce finite element methods for the analysis of solids and structures. The following topics will be considered: procedure for defining a mechanics problem (governing equations, constitutive equations, boundary and initial value problems); theory and implementation of the finite element method for static analysis using linear elasticity; and the verification/validation of results using finite element analysis software.
*Course Note:* This course is a requirement for the Structural Engineering focus area.

**565.429 Preservation Engineering (3)**
The renovation of existing buildings often holds many advantages over new construction, including greater economy, improved sustainability, and the maintenance of engineering heritage and architectural character in our built environment. Yet, the renovation of existing structures presents many challenges to structural engineers. These challenges include structural materials that are no longer in widespread use (e.g., unreinforced masonry arches and vaults, cast iron, and wrought iron) as well as structural materials for which analysis and design practices have changed significantly over the last half-century (e.g., wood, steel, and reinforced concrete). This course will examine structures made of a wide variety of materials and instruct the student how to evaluate their condition, determine their existing capacity, and design repairs and/or reinforcement. The investigation and analysis procedures learned from this course may then be applied to create economical and durable structural alterations that allow for the reuse of older buildings. Site visits near Homewood campus will supplement lectures.

**565.430 Design of Wood Structures (3)**
This course introduces students to the design of wood structures. Wood structures may be constructed of sawn lumber, glulam, or engineered wood products. The primary focus in this class is on light-framed low-rise wood buildings constructed of sawn lumber or glulam, but concepts related to heavy timber-framed structures and tall wood buildings using cross-laminated timber (CLT) are introduced. Structural behavior under gravity and lateral loads is emphasized, as is analysis and design of the components within the gravity and lateral load resisting systems. The current version of the National Design Specification (NDS) for Wood Construction is used.

**565.450 Introduction to Construction Management (3)**
An introduction to the "business side" of construction projects. Topics include an evaluation of delivery systems used in construction projects (fixed price, cost plus, design-build, design-bid-build, etc.), CPM scheduling, techniques for resolving job site conflicts and schedule delays, and Building Information Management (BIM).

**565.460 Catastrophe Modeling: An Engineer's Guide to Disaster Risk Management (3)**
An Introduction to the elements of the theory and practice of disaster risk management (DRM). This class will provide hands-on experience in quantitative modeling of risk with an open catastrophe modeling tool, enable attendants as risk practitioners to query the right questions and interpret complex results, highlight differences in modeling approaches (aggregated v. site specific analyses), decide among diverse risk estimates of the same phenomenon, and estimate project costs associated with disasters.

**565.475 Advanced Soil Mechanics (3)**
This course discusses the difference between soils and other materials; stresses in soils due to structural foundations; elastic, consolidation, and secondary consolidation settlements of footings; shear strength and stress-strain behavior of clays and sands; approximate nonlinear elastic, Mohr–Coulomb, Ramberg–Osgood, and hyperbolic stress-strain models for soils; nonlinear Winkler foundation analysis of piles, pile groups, and drilled shafts due to vertical and horizontal loads; and foundation spring constraints for superstructure analysis.
Prerequisite: 560.305 Soil Mechanics or equivalent.
*Course Note:* This course is a requirement for the Geotechnical Engineering focus area.

**565.480 Earth Engineering (3)**
This course primarily deals with design and construction methods of Earth embankments, as well as concepts related to soil as construction material. Covered topics include subsurface exploration techniques, soil classification methods, stress distribution theories, elastic and consolidation settlement analysis, cut and fill embankment construction, groundwater and seepage, compaction theory, and embankment slope stability. Case histories of embankment on soft ground will be discussed, with introduction to advanced topics such as staged construction, physical and chemical soil stabilization, and pile supported embankments. Discussions on testing of embankment during construction and performance monitoring with geotechnical instrumentation will be provided.
*Prerequisite:* 560.305 Soil Mechanics or equivalent
*Course Note:* This course is a requirement for the Geotechnical Engineering focus area.

**565.600 Structural Mechanics (3)**
This course presents basic solid mechanics for structural engineers, including stress, strain, and constitutive laws; linear elasticity and visco-elasticity; introduction to nonlinear mechanics; static, dynamic, and thermal stresses; specialization of theory to one- and two-dimensional cases; plane stress and plane strain, rods, and beams; work and energy principles; and variational formulations.
*Course Note:* This course is a requirement for the Structural Engineering focus area.

**565.605 Advanced Reinforced Concrete Design (3)**
This intensive course covers reinforced concrete materials and specifications and includes the following topics: conception, analysis, and design of continuous beams and frames; building; bridges and shells; elements theory, with emphasis on the ultimate strength method; precast and prestressed concrete; and special topics.
*Prerequisite:* 560.325 Concrete Structures or equivalent.

**565.620 Advanced Steel Design (3)**
This course examines advanced designs of structural steel building, including consideration of torsion, lateral-torsional buckling, plastic design, plate girders, framing systems for seismic design, and principles of stability including the direct analysis method.
*Prerequisite*: 560.320 Steel Structures or equivalent.

**565.625 Advanced Foundation Design (3)**
The course covers performance requirements and review of soil mechanics, laboratory testing, and the latest subsurface investigation and in situ testing methods as they relate to foundation design; bearing capacity and settlements of shallow foundations; design and construction of rammed aggregate piers; design and construction of driven and drilled deep foundations; axial and lateral capacity and settlement of deep foundations; dynamic analysis and evaluation by wave equation and dynamic testing methods; axial load tests and interpretation; and pile integrity testing.
*Prerequisites:* 565.475 Advanced Soil Mechanics.

**565.629 Preservation Engineering in the Urban Context (3)**
Technical expertise is fundamental to design and construction within and around historic buildings in the urban context. This course will cover topics related to both design and construction. For below-grade engineering, the course will cover underpinning, bracket piles, secant piles, slurry walls, tie-backs and general shoring approaches to building below or adjacent to existing constructions. For upward additions to existing construction, the course covers strengthening techniques (including temporary shoring and bracing, temporary access options, and temporary protection) and the requirements of the International Existing Building Code (IEBC). Each class will provide both technical guides and case studies, offering perspectives from guest speakers practicing the diverse range of professions tasked to meet this challenge.

**565.630 Prestressed Concrete Design (3)**
Topics include prestressed concrete materials, prestressing systems, and loss of prestress; analysis and design of sections for flexure, shear, torsion, and compression; and consideration of partial prestress, composite sections, and slabs.
*Prerequisites*: 560.325 Concrete Structures or equivalent.

**565.635 Ground Improvement Methods (3)**
This course addresses the selection, cost, design, construction, and monitoring of ground improvement methods for problematic soils and rock. Ground improvement methods covered include wick drains, micropiles, lightweight fill materials, soil nailing, mechanically stabilized slopes and walls, grouting, stone columns, dynamic compaction, and soil mixing.
*Prerequisites:* 560.330 Foundation Design or equivalent and 565.475 Advanced Soil Mechanics.

**565.640 Instrumentation in Structural and Geotechnical Engineering (3)**
This course introduces concepts, technologies, procedures, and applications of instrumentation in structural and geotechnical engineering. The structural applications include bridge load rating, fatigue evaluation, connection/bearing performance, and problem diagnosis. The geotechnical applications include in situ determination of soil and rock properties and performance monitoring of soil and foundation elements. Geotechnical instrumentation details will include design phase, construction phase, and post-construction phase applications.

**565.645 Marine Geotechnical Engineering (3)**
This course introduces students to soil mechanics in the marine environment. Topics covered include the nature of marine sediments, soil behavior due to cyclic loading, marine geotechnical investigations, shallow foundations and dead-weight anchors, pile foundations and anchors, penetration and breakout of objects on the seafloor, marine slope stability, soft ground improvement, marine dredging, and project planning.
*Prerequisites:* 560.305 Soil Mechanics or equivalent.

**565.650 Port and Harbor Engineering (3)**
Planning and engineering of ports and harbors has received renewed worldwide interest as the newest super-large cargo ships push the envelope for channel depth and berth space. This course covers planning of marine terminals and small-craft harbors, ship berthing and maneuvering considerations, port navigation, marine structures, inland navigation, marine construction planning, sediment management, and port economics. A field trip to the Port of Baltimore provides practical application of course material and shows students firsthand the unique challenges of engineering on the waterfront.

**565.660 Design of Ocean Structures (3)**
This course presents a review of structural design theory and practice. Basic structural elements of coastal and offshore structures are designed using current engineering design codes developed by the American Wood Council, American Institute of Steel Construction, American Petroleum Institute, and American Concrete Institute. Topics include connection methods, material properties, and design of concrete, timber, and steel ocean structures.

**565.670 Coastal Structures (3)**
This course covers the practical design and analysis of seawalls, breakwaters, groins, and jetties. Topics include wave forces, sediment transport, and coastal zone planning.

**565.715 Application of Numerical Methods in Geotechnical Engineering (3)**
This course presents a review of different numerical methods and their applicability and limitations to analysis and design in geotechnical engineering. The course includes an overview of finite differences, boundary elements, and the finite element method (FEM) for stress-strain analysis of soil constructions and limit equilibrium methods for slope stability analysis. Also included are applications of FEM and slope stability software to analysis and design in geotechnical engineering.

**565.742 Soil Dynamics and Geotechnical Earthquake Engineering (3)**
This course provides a study of soil behavior under dynamic loading conditions, including wave propagation and attenuation, field and laboratory techniques for determining dynamic soil properties and cyclic strength, cyclic stress strain behavior of soils, liquefaction and evaluation of liquefaction susceptibility, nondestructive evaluation of foundation systems, and foundation design for vibratory loadings.
*Prerequisites:* 560.305 Soil Mechanics or equivalent.

**565.745 Retaining Structures and Slope Stability (3)**
Topics for this course include Earth pressure theories; design and behavior of rigid, flexible, braced, tied-back, slurry, and reinforced soil structures; stability of excavation, cut, and natural slopes; methods of slope stability analysis; effects of water forces; shear strength selection for analysis; and stability and seepage in embankment dams.
*Prerequisites:* 560.305 Soil Mechanics or equivalent.

**565.752 Structural Dynamics (3)**
This course provides a brief review of rigid-body dynamics, Lagrange's equations and Hamilton's principle, free and deterministic forced vibration of undamped and damped single- and multi-degree of freedom systems, vibration of continuous systems, approximate methods of analysis, and introduction to random vibration of linear systems.

**565.756 Earthquake Engineering I (3)**
Topics for this course include plate tectonics, seismicity of Earth, and engineering seismology—including quantification and classification of earthquake ground motions, dynamics of structures subjected to earthquake loads, design spectra, building code provisions, design concepts and detailing, soil-structure interaction, and response of special structures.

**565.758 Wind Engineering (3)**
This course covers atmospheric circulation, atmospheric boundary layer winds, bluff-body aerodynamics, modeling of wind-induced loads, introduction to random vibration theory, response of structures to fluctuating wind loads, aeroelastic phenomena, wind-tunnel and full-scale testing, nonsynoptic winds (hurricanes, tornadoes, etc.), and wind-load standards and design applications.

**565.766 Earthquake Engineering II (3)**
This course teaches the principles of seismic-resistant design in terms of importance of ductile behavior of materials, members, and structural systems (with emphasis on the seismic "fuse" concept). Seismic design practice for steel and concrete structures per the current US codes will be covered for structural systems that include steel moment frames, steel braced frames, concrete moment frames, concrete shear wall systems, buckling restrained braced frames, and others.
*Prerequisite:* 565.756 Earthquake Engineering I.

**565.784 Bridge Design and Evaluation (3)**
This graduate-level course covers primary subjects and fundamental principles for the design of new bridges and the evaluation of existing bridges in accordance with current AASHTO specifications. The general procedures of bridge design and bridge evaluation, respectively, will be discussed, and the corresponding AASHTO code requirements will be explained through

examples. In addition, modern technologies for condition assessment and monitoring of existing bridges will be introduced.

*Course Notes:* No textbook will be required. Necessary course materials will be provided through handouts.

## Appendix B

### Evidence of Compliance with the Principles of Good Practice (as outlined in COMAR 13B02.03.22C)

**(a) Curriculum and Instruction**

**(i) A distance education program shall be established and overseen by qualified faculty.**

This is already a well-established site-based program; many of the faculty teaching in the on-site program also serve as online instructors. Any new instructor recruited to teach online would be required to meet the same qualifications as those teaching in the traditional site-based program.

**(ii) A program's curriculum shall be coherent, cohesive, and comparable in academic rigor to programs offered in traditional instructional formats.**

Most of the courses in the online program are offered in the traditional, site-based program. Prior to a course being converted for online delivery, the course is usually taught at least twice in class. A formal online course development process is used to support the course conversion from in-class to online. The online course development process incorporates the Quality Matters™ research-based set of eight standards for quality online course design to ensure the academic rigor of the online course is comparable or better to the traditionally offered course.

**(iii) A program shall result in learning outcomes appropriate to the rigor and breadth of the program.**

The program learning outcomes for the distance education program are identical to the traditional on-site program (please see section B.2). The program learning outcomes are derived from input from professionals within the discipline, the program instructors, program leadership and other program stakeholders.

**(iv) A program shall provide for appropriate real-time or delayed interaction between faculty and students.**

The Master of Civil Engineering will be delivered via Blackboard, JHU's course management system. This platform supports asynchronous interaction between faculty and students. Students and faculty also have the option to participate in optional "real-time" interaction through weekly web-conference office hours, supported by Adobe Connect.

**(v) Faculty members in appropriate disciplines in collaboration with other institutional personnel shall participate in the design of courses offered through a distance education program.**

The program has established a process for identifying the appropriate faculty to design an online course. All faculty members are selected based on domain expertise and program-related teaching experience.

**(b) Role and Mission**

**(i) A distance education program shall be consistent with the institution's mission.**

Refer to Section A.1 in the main body of the proposal.

**(ii) Review and approval processes shall ensure the appropriateness of the technology being used to meet a program's objectives.**

The development of online courses is supported by JHU-EP's Center for Learning Design and Technology (CLDT) professional staff, which includes instructional designers, instructional support specialists and other supporting staff. Each online course development is assigned an instructional designer. The course instructor(s) consults with the instructional designer during the course design process to determine the most effective learning technologies and strategies needed to meet the course learning objectives. The course design goes through multiple reviews by the instructional designer and program chairs. The program chairs are responsible for making sure the course design meets the program's expectations for online courses and that the course learning objectives reflect what the program expects students to achieve after completing this course. Once the online course launches, the assigned instructional designer continually monitors the courses, and consults with the instructor(s) to make adjustments to the course, if needed. All new online courses participate in a mid-term and end-of-term course evaluation process. The mid-term feedback is used to determine if any mid-point term corrections are needed. The end-of-term feedback is used to assess whether further course refinements are needed prior to the next time the course is offered.

**(c) Faculty Support**

**(i) An institution shall provide for training for faculty who teach with the use of technology in a distance education format, including training in the learning management system and the pedagogy of distance education.**

Faculty support for the development of online courses is provided by JHU-EP's CLDT professional staff. Faculty have multiple opportunities to receive training in the learning management system, and pedagogy of online learning – these opportunities are presented at various times throughout the year at events such as fall/spring annual faculty meetings, Brown Bag workshops, webinars, and scheduled training sessions. Once instructors have been identified to develop an online course, they are given access to a set of web-based resources that cover a broad range of topics on online pedagogy, use of instructional technologies and learning management system tutorials. Throughout the online course development, the instructor receives direct support and

guidance from the assigned instructional designer on a variety of online learning related topics.

**(ii) Principles of best practice for teaching in a distance education format shall be developed and maintained by the faculty.**

The JHU-EP CLDT has created a series of online teaching strategies resources. These resources are based on best practices from research and other related sources. All new online course instructors are encouraged to review these resources prior to teaching their first online course. New online instructors also receive one-on-one coaching from instructional designers and peer mentors.

**(iii) An institution shall provide faculty support services specifically related to teaching through a distance education format.**

The JHU-EP CLDT provides a wide range of faculty support services for instructors engaged in online instruction. Instructors have access to multimedia specialists, instructional technologists, instructional designers, a training specialist and other institutional support staff to assist them in their role as online instructors. Some of the services provided include instructional technology training, course design support, learning management system training, course production support (i.e., recording studio), video production, and a faculty support help line and email.

**(d) An institution shall ensure that appropriate learning resources are available to students including appropriate and adequate library services and resources.**

The students will have online access to the Milton S. Eisenhower Library on the Homewood campus, which is ranked as one of the nation's foremost facilities for research and scholarship. Its collection of more than three million bound volumes, several million microfilms, and more than 13,000 journal subscriptions has been assembled to support the academic efforts of the University. The interlibrary loan department makes the research collection of the nation available to faculty and students. The library also provides easy access to a wide selection of electronic information resources, including the library's online catalog, and numerous electronic abstracting and indexing tools. Many of the databases are accessible remotely. Librarians help students electronically and the library maintains an extensive web site to take visitors through all of its services and materials.

**(e) Students and Student Services**

**(i) A distance education program shall provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.**

JHU-EP maintains numerous web-based resources to inform prospective students on the information they may need as an online student. These resources include: EP main website (http://ep.jhu.edu); EP online catalog, which includes detailed programmatic information, academic support services, financial aid, costs, policies, etc. and specific information for online learning (refer to http://catalog.ep.jhu.edu/content.php?catoid=20&navoid=630). As new online students are admitted and enrolled, they receive timely emails with important information to help them prepare to become an online student. These emails include information on how to create their JHU login account for the course management systems, technical requirements, available academic support services and new online student orientation course.

**(ii) Enrolled students shall have reasonable and adequate access to the range of student services to support their distance education activities.**

JHU-EP online students have access to the following academic support services:

- **Academic Advising**. Students are assigned an advisor when accepted. Students in most master's degree programs are requested to submit a program planning form for their advisor's approval. Students work individually with the advisor to develop a course of study that meets the requirements of the program and the career goals of the student. The advisor is expected to contact all advisees each semester to check on progress and answer questions. Courses that deviate from the program plan and have not been approved by an advisor may not count toward degree requirements.

- **Library Services.** Students have online access to the Milton S. Eisenhower Library on the Homewood campus, ranked as one of the nation's foremost facilities for research and scholarship. The interlibrary loan department allows students access to resources at any other university in the nation. The library also provides easy access to a wide selection of electronic information resources, including the library's online catalog and numerous electronic abstracting and indexing tools. Many of the databases are accessible remotely. Librarians are available to assist students remotely and the library maintains an extensive web site to take visitors through all its services and materials.

- **Services for Students with Disabilities.** The Johns Hopkins University is committed to making all academic programs, support services, and facilities accessible to qualified individuals. Students with disabilities who require reasonable accommodations can contact the EP Disability Services Administrator.

- **Johns Hopkins Student Assistance Program.** The Johns Hopkins Student Assistance Program (JHSAP) is a professional counseling service that can assist students with managing problems of daily living. JHSAP focuses on problem solving through short-term counseling. Accessing the service is a simple matter of a phone call to arrange an appointment with a counselor. Online students may

call a phone number for consultation and will be directed to the appropriate resource or office. JHSAP services are completely confidential. The program operates under state and federal confidentiality legislation and is HIPAA compliant.

- **Transcript Access.** Official transcripts will be mailed upon written request of the student at no charge.

- **Student ID JCard.** The JCard serves as the student's University identification card. This card is mailed to the home address of every registered student. The JCard acts as the university library card, which enables students to check out books from the Homewood Eisenhower Library or at any of the campus center libraries, and provides access to many computer laboratories.

**(iii) Accepted students shall have the background, knowledge, and technical skills needed to undertake a distance education program.**

All accepted online students are required to have met the admission requirements stated for the degree program. New online students are strongly encouraged to complete the "New Online Student Orientation" course prior to beginning their first online course. This course covers a broad range of topics on how to be a successful online student such as: online student learning expectations, how to access the library, how to conduct online research, and how to participate in online discussions.

**(iv) Advertising, recruiting, and admissions materials shall clearly and accurately represent the program and the services available.**

All relevant program information is keep up to date on the JHU-EP web site (http://ep.jhu.edu).

**(f) Commitment to Support**

**(i) Policies for faculty evaluation shall include appropriate consideration of teaching and scholarly activities related to distance education programs.**

Faculty teaching online courses are strongly encourage to participate in minimally one to two professional development opportunities annually to improve their online teaching skills.

**(ii) An institution shall demonstrate a commitment to ongoing support, both financial and technical, and to continuation of a program for a period sufficient to enable students to complete a degree or certificate.**

Please see sections J and K of the proposal.

## (g) Evaluation and Assessment

**(i) An institution shall evaluate a distance education program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.**

Please see Section L of the main body of the proposal.

**(ii) An institution shall demonstrate an evidence-based approach to best online teaching practices.**

The JHU-EP CLDT instructional design and faculty support staff continually participate in professional development activities to keep abreast of evidence-based approaches to online teaching practices. These online teaching practices are then incorporated into the new online instructor training sessions.

**(iii) An institution shall provide for assessment and documentation of student achievement of learning outcomes in a distance education program.**

As part of the online course design process, course assessments are required to be aligned with stated course learning outcomes. The JHU-EP program, where appropriate, incorporates authentic-based learning assessments that demonstrate student's application of learned concepts.

## Appendix C

## Faculty

| First Name | Last Name | Terminal Degree | Field | Academic Title/Rank | Status | Courses taught |
|---|---|---|---|---|---|---|
| Xin | Chen | PhD | Civil Engineering | Assistant Division Chief, Maryland State Highway Administration Office of Materials Technology | Part-time | 565.635, 565.745 |
| Jay (John) | Harris | PhD | Civil Engineering | Research Structural Engineer, National Institute of Standards and Technology | Part-time | 565.756 |
| Carol | Hayek | PhD | Civil Engineering | Chief Technical Officer, CCL Group, Baltimore, MD | Part-time | 565.630 |
| Houda | Jadi | PhD | Civil Engineering | (formerly) Senior Project Engineer, Golder Associates, LTD., Mississauga, Ontario | Part-time | 565.475 |
| Siva | Kesavan | PhD | Civil Engineering | Senior Project Engineer, Whitman, Requardt, and Associates | Part-time | 565.480, 565.640 |
| John | Matteo | MS | Civil Engineering | Principal, 1200 Architectural Engineers, PLLC | Part-time | 565.429, 565.629 |
| Ed | Meade | MA | Civil Engineering | Dir. of Historic Preservation, Robert Silman Associates | Part-time | 565.429, 565.629 |
| Sarah | Mouring | PhD | Civil Engineering | Professor, U.S. Naval Academy | Part-time | 565.645, 565.650, 565.660, 565.671 |

## Appendix D

## Finance Information

| TABLE 1: RESOURCES | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 1. Reallocated Funds | $0 | $0 | $0 | $0 | $0 |
| 2. Tuition/Fee Revenue (c + g below) | $313,650 | $366,325 | $463,401 | $610,581 | $770,069 |
| a. Number of F/T Students | 0 | 0 | 0 | 0 | 0 |
| b. Annual Tuition/Fee Rate | - | - | - | - | - |
| c. Total F/T Revenue (a x b) | $0 | $0 | $0 | $0 | $0 |
| d. Number of P/T Student Enrollments | 85 | 95 | 115 | 145 | 175 |
| e. Credit Hour Rate | $1,230 | $1,285 | $1,343 | $1,404 | $1,467 |
| f. Credits Per Course | 3 | 3 | 3 | 3 | 3 |
| g. Total P/T Revenue (d x e x f) | $313,650 | $366,325 | $463,401 | $610,581 | $770,069 |
| 3. Grants, Contracts & Other Ext Sources | $0 | $0 | $0 | $0 | $0 |
| 4. Other Sources | $0 | $0 | $0 | $0 | $0 |
| **TOTAL (Add 1 – 4)** | **$313,650** | **$366,325** | **$463,401** | **$610,581** | **$770,069** |

Resources Narrative

1. Reallocated Funds: The proposed program will be funded by tuition revenue, and will make no use of reallocated funds.
2. Tuition and Fee Revenue: The enrollment projections in Table 1 are a reasonable estimate based on growth of other JHU-EP master's degree programs when moved online. The Master of Civil Engineering is a part-time degree program, so no full-time students are expected. JHU-EP students take, on average, three 3-credit courses per year, which is reflected in the "Annual Credit Hour Rate."
3. Grants and Contracts: No grants or contacts are required for the successful implementation of the program.
4. Other Sources: The program does not expect any funding from other source.

**Note:** The resources data for the Master of Civil Engineering is combined with those for the Post-Baccalaureate Certificate in Civil Engineering, as they share the same courses, and all resources and expenditures in these programs are course-based.

| TABLE 2: EXPENDITURES | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 |
|---|---|---|---|---|---|
| 1. Faculty (b + c below) | $131,015 | $114,544 | $175,253 | $168,827 | $192,463 |
| a. # Sections offered | 9 | 10 | 10 | 13 | 15 |
| b. Total Salary | $121,310 | $106,060 | $162,271 | $156,321 | $178,206 |
| c. Total Benefits | $9,705 | $8,485 | $12,982 | $12,506 | $14,256 |
| 2. Admin. Staff (b + c below) | $26,800 | $27,336 | $27,883 | $28,440 | $29,009 |
| a. # FTE | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| b. Total Salary | $20,000 | $20,400 | $20,808 | $21,224 | $21,649 |
| c. Total Benefits | $6,800 | $6,936 | $7,075 | $7,216 | $7,361 |
| 3. Support Staff (b+c below) | $48,501 | $19,691 | $79,947 | $40,573 | $41,182 |
| a. # FTE | 0.625 | 0.25 | 1 | 0.5 | 0.5 |
| b. Total Salary | $36,060 | $14,640 | $59,440 | $30,166 | $30,618 |
| c. Total Benefits | $12,441 | $5,051 | $20,507 | $10,407 | $10,563 |
| 4. Equipment | $0 | $0 | $0 | $0 | $0 |
| 5. Library | $0 | $0 | $0 | $0 | $0 |
| 6. New or Renovated Space | $0 | $0 | $0 | $0 | $0 |
| 7. Other Expenses | $84,315 | $97,061 | $121,020 | $157,169 | $195,377 |
| **TOTAL (Add 1 – 7)** | **$290,631** | **$258,633** | **$404,103** | **$395,009** | **$458,030** |

Expenditures Narrative

1. Faculty: The Engineering for Professionals lecturers are paid $8,495 (for FY15) per course taught or developed. This was used as the base rate. For years 1 – 5, an additional 2% was added to the salary rate. The fringe rate is estimated at 8%.
2. Administrative Staff: Includes pro-rated salary for high-level program managerial support.
3. Support Staff: Includes pro-rated salaries for F/T Instructional Designers to assist in developing online courses.
4. Equipment: No direct equipment costs are identified.
5. Library: Existing library facilities are sufficient to meet the needs of the program.
6. New or Renovated Space: No new or renovated space will be needed.
7. Other Expenses: Indirect program costs (per enrollment) are provided here.