MORGAN STATE UNIVERSITY
GROWING THE FUTURE • LEADING THE WORLD

Provost and Senior Vice President for Academic Affairs

May 16, 2022

The Honorable Dr. James D. Fielder, Jr.
Maryland Higher Education Commission
6 N. Liberty Street, 10th Floor
Baltimore, MD 21201

Dear Dr. Fielder,

On behalf of Morgan State University, please find attached a proposal to establish the "*Doctor of Philosophy (Ph.D.) in Sustainable and Resilient Infrastructure Engineering (SRIE) with a pass-through (En Passant) Master of Science (M.S.) in Sustainable and Resilient Infrastructure Engineering (SRIE)"* which was approved by the Board of Regents on May 3, 2022.

If additional information is required, please contact me at hongtao.yu@morgan.edu or (443)885-3350.

Sincerely,

Hongtao Yu, PhD
Provost and Senior Vice President for Academic Affairs, Morgan State University

cc: Dr. David Wilson, President, Morgan State University
Dr. Phyllis Keys, Interim Associate Vice President for Academic Affairs, MSU
Dr. Oscar Barton, Dean, School of Engineering, MSU
Dr. Emily Dow, Assistant Secretary for Academic Affairs, Maryland Higher Education Commission

1700 E. Cold Spring Lane • 300 Truth Hall • Baltimore, Maryland 21251
Tel: 443-885-3350 • Fax: 443-885-8289

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Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	Morgan State University

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No Payment Type: (●) R*STARS # ( ) Check # Payment Amount: $850 Date Submitted: 5/15/22

Department Proposing Program	School of Engineering	
Degree Level and Degree Type	Ph.D. with a pass-through M.S.	
Title of Proposed Program	Sustainable and Resilient Infrastructure Engineering (SRIE)	
Total Number of Credits	60	
Suggested Codes	HEGIS: 908.00	CIP: 14.0801
Program Modality	(●) On-campus ( ) Distance Education (*fully online*)	
Program Resources	( ) Using Existing Resources (●) Requiring New Resources	
Projected Implementation Date	(●) Fall ( ) Spring ( ) Summer	Year: 2023
Provide Link to Most Recent Academic Catalog	URL: catalog.morgan.edu	
Preferred Contact for this Proposal	Name: Dr. Phyllis Keys	
	Title: Interim Associate Vice President for Academic Affairs	
	Phone: (443) 885-3350	
	Email: Phyllis.Keys@morgan.edu	
President/Chief Executive	Type Name: Dr. Hongtao Yu, Provost & Senior Vice President for Academic Affairs	
	Signature: [signature]	Date: 05/16/2022
	Date of Approval/Endorsement by Governing Board:	05/03/2022

Revised 1/2021

Morgan State University

School of Engineering

Proposed Doctor of Philosophy (Ph.D.) in Sustainable and Resilient Infrastructure Engineering (SRIE) with a pass-through (e*n passant*) Master of Science (M.S.) in SRIE (including study within seven concentrations)

A. Centrality to Institutional Mission and Planning Priorities

Morgan State University (MSU) is the premier urban public research university in Maryland, known for its excellence in teaching, intensive research, effective public service, and community engagement. Morgan prepares diverse and competitive graduates for success in a global, interdependent society.

Mission Statement: *Morgan State University serves the community, region, state, nation, and world as an intellectual and creative resource by supporting, empowering and preparing high-quality, diverse graduates to lead the world. The University offers innovative, inclusive, and distinctive educational experiences to a broad cross-section of the population in a comprehensive range of disciplines at the baccalaureate, master's, doctoral, and professional degree levels. Through collaborative pursuits, scholarly research, creative endeavors, ad dedicated public service, the University gives significant priority to addressing societal problems, particularly those prevalent in urban communities.*

Morgan State University (Morgan) proposes a new academic graduate degree program, Doctor of Philosophy in Sustainable and Resilient Infrastructure Engineering (hereafter the "Ph.D. in Sustainable and Resilient Infrastructure Engineering" or the "Program"). The Program is offered through the Department of Civil Engineering (CE) in the School of Engineering (SoE).

A.1. Program Description

In the United States, infrastructure is crucial for the activities of everyday life, productivity, and the economy. The built environment, comprising airports, bridges, buildings, dams, ports, rail, roads, stormwater practices, transit, water, and wastewater systems, is vital to these functions. Unfortunately, these critical infrastructures are vulnerable to natural and man-made disasters and are chronically stressed due to aging. These complexities present themselves as an opportunity for new academic programs focused on addressing the present and future needs for sustainable and resilient civil infrastructure.

Students in this program study a combination of scientific and engineering principles to ensure the design, management, and innovation of sustainable, resilient infrastructure systems. Students enrolled in this program will acquire knowledge in a range of traditional civil and environmental engineering domains, as well as cross-disciplinary strategies, analytical tools, and research methods to optimize, plan, and manage critical infrastructure risks while meeting sustainability standards. The Ph.D. program in Sustainable and Resilient Infrastructure Engineering (SRIE) targets highly motivated students who have already obtained a Bachelor's or Master's degree and desire to pursue career opportunities in academia, industry, federal and state agencies, NGOs, consulting engineering firms, or research.

A.1.1 Program of Study

The program will utilize the courses currently available in the inventory of WebSIS at Morgan State University. Section G4.5 of this proposal gives all graduate-level industrial engineering courses available in the inventory at Morgan State University, together with the course descriptions. The required minimum coursework for the Ph.D. in Sustainable and Resilient Infrastructure Engineering is 60 equivalent credit hours beyond the bachelor's degree and 36 equivalent credit hours beyond the master's degree. The graduate courses comprised of: (1)

Foundation Courses (each credit is equivalent to 1 credit-hour of graduate coursework) of which students may study within a concentration and be advised of core courses to take; (2) Elective Courses (each credit is equivalent to 1 credit-hour of graduate coursework); (3) Research Area Courses where each credit is equivalent to 3 credit-hours of graduate coursework; (4) Graduate Seminar, and (5) Dissertation Research.

Table A1: Credit breakdown for students pursuing a Ph.D. immediately following the Bachelor's Degree (60 equivalent graduate credit hours required beyond the Bachelor's Degree).

Foundation	
Elective Courses (8)	24 credits
Research courses (5)	15 credits
Graduate Seminar (1)	3 credits
Dissertation Research (5)	15 credits
Dissertation Defense (1)	3 credits
Total	**60 credits**

Note: At least three foundation elective courses from the same track are required for a concentration in SRIE

Table A2: Credit breakdown for students pursuing a Ph.D. immediately following the Master's Degree (36 equivalent graduate credit hours required beyond a Master's Degree).

Foundation Elective Courses (3)	9 credits
Research Courses (2)	6 credits
Graduate Seminar (1)	3 credits
Dissertation Research (5)	15 credits
Dissertation Defense (1)	3 credits
Total	**36 credits**

From Table A2, students with a master's degree in the approved areas listed in Table A3 will be required to take a minimum of 36 equivalent graduate credit hours, including: 9 credits of Elective Courses, 6 credits of Research Courses, 3 credits of Graduate Seminar, 15 credits of Dissertation Research, and 3 credits of Dissertation Defense.

Table A3: List of approved Master's Degree programs for direct admission to the Ph.D. in the SRIE program.

Masters of Engineering
Masters of Civil Engineering
Masters of Environmental Engineering

Students who have a Master's degree, but not in one of the approved degree programs listed in Table A3 will need to be reviewed and granted approval from the Department's Graduate Faculty committee and Graduate Program Director to take the 36-credit option. Prospective students should seek guidance from the Graduate Program Director during the application process regarding the approval of Master's degrees.

A.2. Strategic Goals Support and Affirmation

Transformation Morgan 2030: Leading the Future, the Strategic Plan for Morgan State University (2021 - 2030) (the Strategic Plan) consists of six broad goals including: *Enhancing Student Success and Well-being*; *Implement Faculty Ascendency and Staff Development Initiatives*; *Elevate Morgan's Status to R1 Very High Doctoral Research University*; *Expand and Improve a Campus-Wide Infrastructure to Support Operational Excellence and Increase Overall Institutional Capacity*; *Serve as the Premier Anchor Institution for Baltimore City and Beyond*; and *Accelerate Global Education Initiatives and Expand the University's International Footprint*. These Strategic Plan goals guide the development and implementation of the University's academic programs, student services, and institutional budgets. The Ph.D. in Sustainable and Resilient Infrastructure Engineering supports four of Morgan's Strategic Plan goals:

Enhancing Student Success and Well-Being: The Program supports Morgan's goal of leading the state of Maryland in graduating underrepresented minority students in STEM disciplines by offering challenging, internationally relevant academic curricula. The establishment of the Ph.D. in Sustainable and Resilient Infrastructure Engineering enhances Morgan's instructional capacity to train professionals to serve the City of Baltimore, the State of Maryland, the region, and the nation by attracting underrepresented students to this program. This program will also contribute to Morgan's expansion of academic program offerings, including new and online degree programs and up-to-date curricula, as well as, enhance research and scholarly activities and capabilities.

Elevate Morgan's Status to R1 Very High Doctoral Research University: As a recently designated Carnegie high research activity university, the Ph.D. in Sustainable and Resilient Infrastructure Engineering will have a profound impact on maintaining and growing our research stature by increasing Ph.D. production, number of publications, and sponsored research funding.

Serve as the Premier Anchor Institution for Baltimore City and Beyond: The Program expands Morgan's impact as Maryland's preeminent public urban research university, as faculty and students will have a particular focus on critical infrastructure challenges facing the City of Baltimore, but also the emerging urban infrastructure challenges faced within our state, region, through the US, and globally.

Accelerate Global Education Initiatives and Expand the University's International Footprint: The program intends to attract and enroll a growing number of international students already drawn to our existing Master's and Doctoral programs. We will leverage ongoing partnerships in West Africa, as Morgan steers towards expanding the institution's footprint into Latin America and Caribbean nations.

A.3. Five Year Funding Plan

Morgan has committed sufficient resources to: 1) hire faculty to teach both online and face-to-face courses; and 2) enhance the research stature of the university via research grants/contracts, journal papers, and technical presentations. To date, six out of the nine total tenure-track faculty slated for this Program have been hired over the past three years in Civil Engineering (CE).

The Department of Civil Engineering has faculty with extensive experience in Civil Engineering and its sub-areas such as Geotechnical, Structure, Environmental, Transportation, Construction, and Water Resources Engineering.

Faculty search is anticipated to hire two more tenure track faculty members. In addition, staff including an instructional laboratory manager, IT manager, and an administrative assistant are already staffed to support the Program.

Our faculty have established research collaborations and strategic partnerships with the National Science Foundation (NSF), USDOT, Maryland Department of Transportation, Carnegie Mellon University, Johns Hopkins University, University of Delaware, and the University of Maryland at College Park.

Our graduate students in the School of Engineering exemplify scholarship as recipients of prestigious national fellowships including the National GEM Consortium. The mission of the National GEM Consortium is to enhance the value of the nation's human capital by increasing the participation of underrepresented groups (African Americans, American Indians, and Hispanic Americans) at the master's and doctoral levels in engineering and science.

A.4. Morgan Commitment

The Ph.D. in Sustainable and Resilient Infrastructure Engineering (SRIE) has received full support from Morgan's President, Dr. David Wilson, and Provost and Senior Vice President for Academic Affairs., Dr. Hongtao Yu. President Wilson has articulated an emerging vision for Morgan focused on urban sustainability and applied research. As a part of the University's strategic plan, the President has charged the University community to focus on intractable challenges facing the local community and communities around the globe as that will elevate Morgan's current Carnegie classification from R2 to R1, high research activity. This program

is well-aligned to address these challenges through fundamental research conducted by the Program's faculty.

Morgan will support the Ph.D. in the SRIE program with 11 faculty, with a potential for an additional three new tenure-track faculty members over the next couple of years. Laboratory facilities within the School of Engineering are well equipped to support associated research and the inclusion of approximately 10 - 15 graduate student researchers on an annual basis.

In alignment with Morgan's mission statement[1] and its planning priorities[2] [3], this proposal for a Ph.D. in SRIE is consistent with Morgan's current mission of serving "the community, region, state, nation, and the world as an intellectual and creative resource by supporting, empowering and preparing high-quality, diverse graduates to lead the world," which is firmly grounded in Enhancing Student Success and Well-being, the first goal of Transformation Morgan 2030: Leading the Future, The Strategic Plan for Morgan State University, 2021-2030. To realize its institutional mission, its legislative designation as Maryland's Preeminent, Public, Urban, Research Institution and its strategic planning goals, and Carnegie R1 designation, Morgan has focused on developing unique high demand degree Programs to offer both in traditional classroom face-to-face settings as well as online.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan

B.1. Program Demand and Need

The Program is consistent with the State of Maryland's goals for maintaining and strengthening a preeminent, statewide array of post-secondary institutions. It responds to the crucial need as highlighted in the 2017-2021 Maryland State Plan for Post-secondary Education, Student Success with Less Debt (State Plan), by ensuring "equitable access to affordable and quality post-secondary education for all Maryland residents." It promotes and implements "practices and policies that will ensure student success" by fostering "innovation in all aspects of the Maryland higher education to improve access and student success." The State of Maryland enjoys a national and international reputation for being "among the nation's leaders of innovation in higher education, highly ranked in research and development with 72 federal laboratories." Similarly, Morgan was officially designated as Maryland's Preeminent Public Urban Research University, and innovation is one of the institution's core values.

The 2009 Maryland State Plan for Postsecondary Education identified five overarching goals addressed, in part, by the proposed Ph.D. program in Sustainable and Resilient Infrastructure Engineering:

- Maintain and strengthen a system of postsecondary education institutions recognized nationally for academic excellence and effectiveness in fulfilling the educational needs of students and the economic and societal development needs of the state and the nation;
- Achieve a system of postsecondary education that promotes accessibility and affordability for all Marylanders;
- Ensure equal opportunity for Maryland's diverse citizenry;
- Achieve a system of postsecondary education that promotes student-centered learning to meet the needs of all Marylanders;
- Promote economic growth and vitality through the advancement of research and the development of a highly qualified workforce.

  Clearly, the proposed Ph.D. program in SRIE addresses the critical and compelling statewide, regionwide and even nationwide need to increase the representation of qualified minorities in a field like civil engineering studies through research, teaching, and mentoring emphases of its proposed Ph.D. program in SRIE.

[1] Appendix IV

[2] Appendix VI

[3] Appendix VII

1. A new doctoral program will strengthen the ongoing research of faculty in the School of Engineering, as doctoral students work as research assistants capable of facilitating faculty research. Faculty supervision of doctoral dissertations will also enhance the faculty's research component.

2. Historically Black Colleges and Universities ("HBCUs") have been primarily teaching institutions, and the teaching dimension of the proposed Ph.D. program in Sustainable and Resilient Infrastructure Engineering reaffirms this tradition by seeking to produce candidates who are not only scholars but also themselves effective college-level teachers, as well as develop a cadre of dedicated professionals.

3. Mentoring, a process of building a mutually beneficial partnership to help develop the skills, behaviors and insights of students, reinforces the above research and teaching goals.

The demand and need for the Program in terms of present and future needs of the region and the State follow.

B.1.1 The need for the advancement and evolution of knowledge

Research methods in the areas of science, engineering, and business have changed significantly over the past few decades. Civil/Infrastructure Engineering professionals are in demand across all areas of STEM. The Baltimore region and the State of Maryland can benefit from their proximity to the metropolitan DC area, …

- Large Maryland employers seeking expertise in Civil Engineering include:
- Federal agencies: NASA, NSF, NIST, EPA, DHS, USACE, USDA
- State: MDE, MDNR, MES, MDOT, SHA
- Municipalities: Baltimore DPW, Baltimore, Prince George's, Anna Arundel, Howard, Montgomery Counties
- Industry: AECOM, Atkins, Biohabitats, EA Engineering, Science, and Technology, Inc., JMT, WRA, RK&K, Century Engineering, WSSC

B.1.2. Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education

For a variety of reasons, the high-tech industry is substantially less diverse than the broader workforce. This lack of diversity is especially acute in the case of African Americans. According to the Equal Opportunity Employment Commission's (EEOC) Special Report on Diversity in High Tech, African Americans make up 14.4% of employees in overall private industry, but only 7.4% of employees and less than 2% of executives in high tech, the lowest rates of any measured racial or ethnic group.

The State of Maryland is home to more than 60 federal agencies and twice as many federal laboratories (74) and features a diversified economy with the fourth-highest concentration of professional and technical workers among the states in the U.S.

The Baltimore/Washington/DC area has a diverse population with a wide variety of job opportunities for the design, planning, and construction areas of civil infrastructure for students who have acquired skills, training, and competency.

B.1.3. Need to strengthen and expand the capacity of HBCUs in Civil Engineering

Maryland has a growing workforce-need shortage in civil engineering … African Americans make up 30.8% of Maryland's population, in contrast with 13.4% of the United States' population. Morgan is also well-positioned to support this community given its proximity.

B.2. Compliance with State Postsecondary Education Plan

The Ph.D. in Sustainable and Resilient Infrastructure Engineering is consistent with the three primary goals outlined in the State Plan, including access, success, and innovation.

Access

In addition to its well-established array of baccalaureate (45), master's (38), doctoral and professional degrees (17), Morgan has also established a strong online presence through the establishment of the office of Morgan Online, an administrative unit for oversight of the new innovative online degree and certificate programs offered by the University. The intent in establishing these online programs is, in large measure, an effort by the University to fulfill its access mission by offering highly flexible degree programs on campus as well as online to expand educational opportunities for traditional students as well as for working students, adult learners, and non-traditional students. As noted in the State Plan,

Non-traditional students now comprise the majority of postsecondary students. Many students have delayed initial enrollment or are returning after earlier enrollment, enroll part-time, are financially independent of parents, support a family, or work full-time. These students have needs and expectations that are often quite different from those of the traditional high school-to-college student.

The Ph.D. in Sustainable and Resilient Infrastructure Engineering is consistent with Morgan's access mission in that by offering the degree on campus to more students, specifically non-traditional students, who will have the opportunity to earn a degree in a high-demand STEM-based program. As African Americans and other minorities continue to be underrepresented in STEM disciplines, offering the Ph.D. in Sustainable and Resilient Infrastructure Engineering at Morgan, one of the State's HBCUs, serves to improve access for students underrepresented in this discipline and career pathway.

Success

The Ph.D. in Sustainable and Resilient Infrastructure Engineering will be integrated into an ongoing set of strategic initiatives focused on ensuring student success. The University has a storied history of success in graduating African Americans, particularly women, and other underrepresented minorities with bachelor's degrees in most of the STEM disciplines.

Innovation

In March (2019), Morgan celebrated its 6th Annual 'Innovation Day' in Annapolis, Md. at the Miller Senate Office Building. Morgan Innovation Day, which serves in part as an annual progress report on the State's premier public urban research institution, "Taking the lead in innovation and providing a pipeline to new technologies is consistent with Morgan's strategic goals and our historical mission of preparing a diverse student body to help the world meet tomorrow's challenges." The Ph.D. program in SRIE enhances Morgan's tradition of providing high-demand and innovative academic programs.

UMD is the only other university in Maryland that offers a Ph.D. program in SRIE. Collaborating with academic, industry, and government stakeholders, the Ph.D. program in SRIE is a degree program designed to provide flexibility to graduate students, working professionals, and non-traditional students to acquire knowledge, skills, and competencies in a career pathway essential to meet the workforce demands of the State and the nation.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State

C.1. Sustainable and Resilient Infrastructure Engineering Industry

The industry opportunities available for the graduates of the Program are strongly associated with those in the field of Civil Engineering. Given the increased risks and hazards due to aging infrastructure, climate change, flooding, and man-made disasters, future civil engineers will need to have strong knowledge and ability in the areas of sustainability and resilience. The proposed Ph.D. program will not only meet the current specialized job needs, but also the anticipated future skills needs for engineers who will have to conceive, design, build,

supervise, operate, construct, and maintain infrastructure under new standards and regulatory constraints. Public infrastructure investment from the federal government into new projects should spur vast opportunities for roads/highways, buildings, airports, tunnels, dams, bridges, and water and sewer systems. Graduates out of this program are also expected to pursue opportunities for careers in research and education.

Maryland has the highest job need for civil engineers while its surrounding 4 states have the average job need for civil engineers in the United States. Civil engineering in Maryland and other coastal states in the United States are facing challenges from sea-level rise and climate change due to global warming and land subsidence due to the Earth's change and human activities. Urban flooding is increasing in frequency and intensity, so risks and hazards to infrastructure are amplified, requiring highly trained engineers and researchers to advance innovation in adaptation and resilience in the region

C.2. Employment Opportunities in Sustainable & Resilient Infrastructure Engineering

SRIE employment opportunities closely align with the field of Civil Engineering. About 25,000 openings for civil engineers are projected each year, on average, over the decade. Many of those openings are expected to result from the need to replace workers who transfer to different occupations or exit the labor force, such as to retire.

Table C1: Job outlook of Civil Engineers.

2020 Median Pay	$88,570 per year $42.58 per hour
Number of Jobs, 2020	309,800
Job Outlook, 2020-30	8% (As fast as average)
Employment Change, 2020-30	25,300

Source: Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Civil Engineers, at https://www.bls.gov/ooh/architecture-and-engineering/civil-engineers.htm (visited *February 20, 2022*).

The employment data in Table C1 supports the relatively high proportion of the U.S. labor force in the industry. Employment of civil engineers is projected to grow 8 percent from 2020 to 2030, about as fast as the average for all occupations. As infrastructure continues to age, civil engineers will be needed to manage projects to rebuild bridges, repair roads/highways, and upgrade levees and dams as well as airports and building structures of all types. The civil engineering industry is historically not vulnerable to large-scale outsourcing prevalent in U.S. industries and depends mostly on the domestic workforce. The success enjoyed by the graduates of the civil engineering and related infrastructure-focused programs serves as anecdotal evidence of the solid market demand for well-trained civil engineering specialists.

C.3. Salaries of Sustainable and Resilient Infrastructure Engineering Professionals

Glassdoor reported in 2020 that the average base salary for a civil engineer with a Ph.D. was $95,000. Specific wage data for civil engineers from the U.S. Bureau of Labor Statistics (BLS) reports that nationally the mean annual wage is $95,440, as of May 2020.

Table C2: Salaries for Civil Engineers at the Ph.D. level. (Source: ASCE 2020 Salary Survey)

Highest Level of Education Attained PhD or equivalent	
Respondents	232
Base Salary	
Average	122,179
Median	112,000
25th Percentile	92,369
75th Percentile	145,000
Total Primary Income	
Average	132,381
Median	119,743
25th Percentile	95,000
75th Percentile	155,490
** Total primary compensation is base salary + commissions + bonuses + net self-employment income.*	

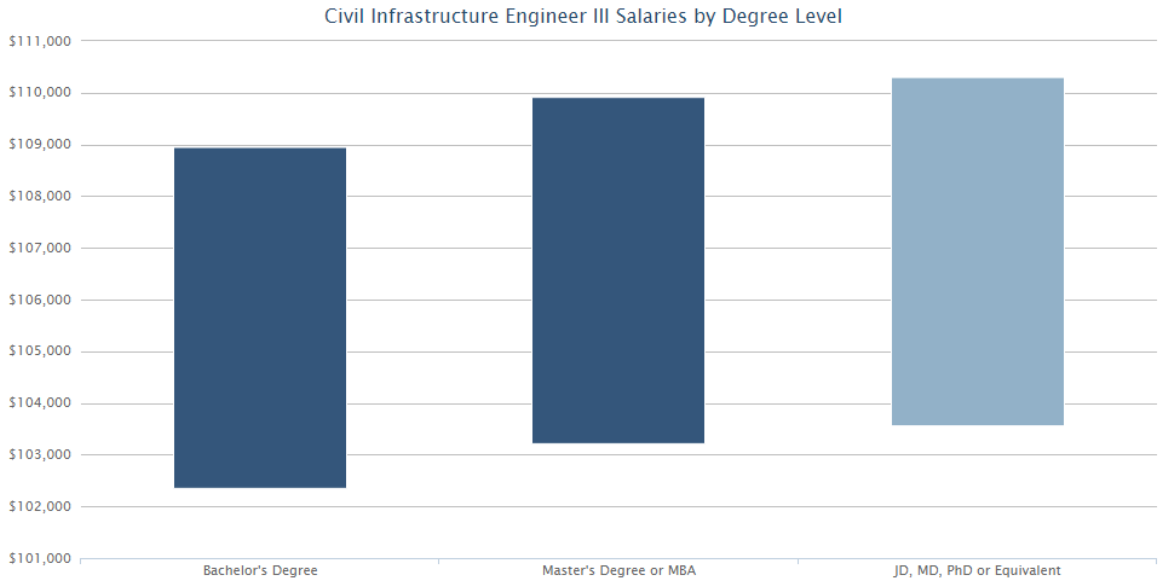
The average Civil Engineer salary in the USA is $95,440 per year or $45.88 per hour[4]. Entry-level positions start at $70,801 per year[5], while most experienced engineers make up to $119,593[6] per year. As shown in Table C2, the average base salary for civil engineers with a Ph.D. or equivalent is $122,179, whereas, the average overall earned income is $132,381, according to the ASCE 2020 Salary Survey. The data also points to the importance of professional licensure and advanced education. Consider that the median salary for civil engineers with a professional engineer license was $121,000, or $31,000 higher than the median for civil engineers without any professional licenses or certifications (ASCE, 2021). Expected entry-level positions for graduates of the Program include careers in academia, federal agencies (e.g., USDOT, USEPA, DoD, USACE), and industry (e.g., AECOM, DC Water, Atkins).

[4] U.S. Bureau of Labor Statistics (2020). "Occupational Employment and Wages, May 2020; 17-2051 Civil Engineers

[5] Salary.com (2022)"Entry Level Civil Engineer Salary.

[6] www.indeed.com https://www1.salary.com/Salaries-for-civil-infrastructure-engineer-iii-with-a-JD-MD-PhD-or-Equivalent

[7] https://www1.salary.com/Salaries-for-civil-infrastructure-engineer-iii-with-a-JD-MD-PhD-or-Equivalent



Civil Infrastructure Engineer III with the following degree	Will likely fall in this salary range
Bachelor's Degree	$102,347 - $108,943
Master's Degree or MBA	$103,211 - $109,909
JD, MD, PhD or Equivalent	$103,556 - $110,296

Figure C1: Civil Infrastructure Engineer III Salaries by Degree Level

According to Salary.com[7], salary sources the median salary for a **Civil Infrastructure Engineer III** with a **JD, MD, PhD or Equivalent** is **$103,556 - $110,296** in Maryland. Students who are graduates of the SRIE PhD program are expected to fall within the range designated for the Civil Infrastructure Engineer III role. SRIE graduates could expect to command salaries in the ranges shown in Figure C1 for the various concentrations represented within SRIE.

C.4. Current and Projected Supply of Prospective Graduates

Congressional Research Service (CRS) analysis of Bureau of Labor Statistics employment projections[7] indicates that the science and engineering workforce is expected to grow from 7.3 million to 8.2 million jobs between 2016 and 2026, an increase of 853,600 (11.7%) jobs over the ten years (1.1% CAGR). This growth rate is higher than the growth rate projected for all occupations (0.7% CAGR) during this period.

Figure C2 and C3 show the science and engineering occupations with the most projected job openings due to growth, labor force exits, and occupational transfers, respectively. While one area of the biggest workforce expansion in Maryland is the projected need for Postsecondary Engineering Educators, expected to grow by 18.12% by 2028[8].

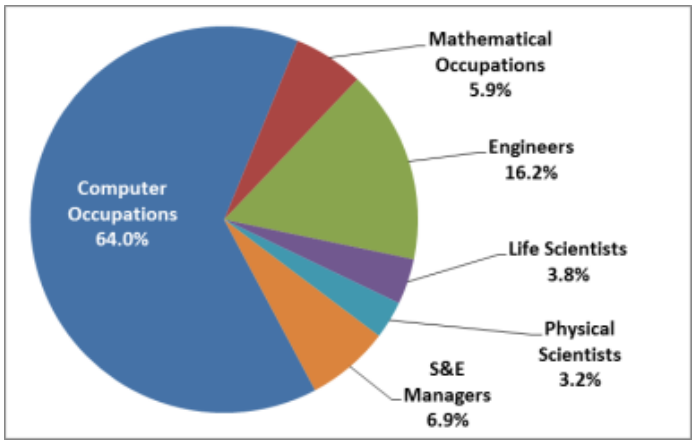


Figure C2: Employment projections from 2016-2026, Bureau of Labor Statistics, U.S. Department of Labor.

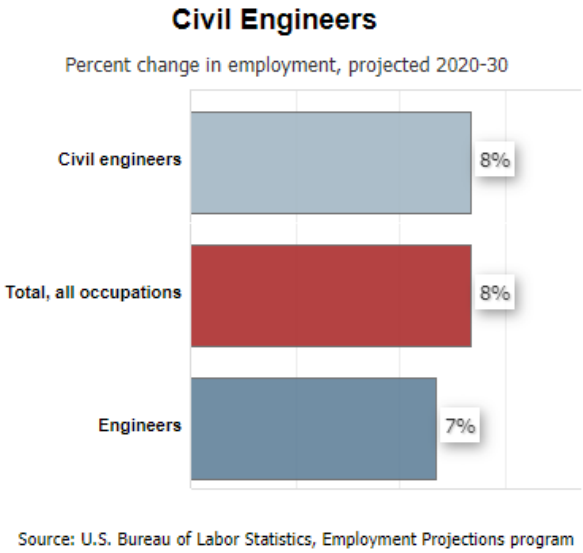


Figure C3: Civil engineering projected job openings due to growth labor force exits and occupational transfers from 2020-2030

[7] https://www.bls.gov/ooh/architecture-and-engineering/computer-hardware-engineers.htm

[8] https://www.dllr.state.md.us/lmi/iandoproj/maryland.shtml

D. Reasonableness of Program Duplication

D.1. Similar Programs

The proposed program is unique from the rest in Maryland as it focuses on the engineering aspects and innovative principles associated with the planning, designing, constructing and managing sustainable and resilient civil engineering infrastructure systems and their interaction. The proposed program is also an expansion of the existing graduate program to incorporate a higher body of knowledge needed to increase the competitiveness of Morgan State University as the predominant urban research university. Similar to the current doctoral degree (D.Eng) program in Civil Engineering at Morgan State University, the Ph.D. program at the University of Maryland at College Park (UMD-CP) and Johns Hopkins University (JHU) aims to educate and train researchers and engineers to take on the challenge of creating and sustaining the built environment that underpins the society. The smooth transition to a Ph.D. awarding Sustainable and Resilient Infrastructure Engineering program will continue to put MSU at the forefront of engineering education and research among Historically Black Institutions (HBI) and inspire the next generation of researchers. These universities (JHU and UMD-CP) including MSU have policies related to their doctoral programs which are available on their websites and their program requirements typically include:

- Number of Courses at 500 to 700 level to be completed with a grade of B or better.
- Qualifying Examination
- Graduate Oral Examination
- Final D.Eng. / Ph.D. Thesis Defense

According to our findings, access to the UMD-CP and JHU programs may be cost-prohibitive for our target applicant pool, as these programs with affirmative action may have adverse effects on the unrepresentative students (e.g., a limited percentage of minority students on campus). The JHU program has a primary focus on structural engineering, structural mechanics, systems engineering, and hazards management. Morgan, on the other hand, targets mainly African Americans.

Tables D1 and D2 show the similarities and differences between the current D.Eng CE program at MSU and other universities in Maryland.

Table D1. Difference from similar programs

Institution	Morgan State University	University of Maryland (at College Park)	John Hopkins University
Institution classification	R2 institution	R1 institution	R1 institution
Control Type	Public	Public	Private
Cost of Tuition 18 credits (AY 2021-2022)	$8,190 (in-state) $16,092 (out-of-state)	$13,824 (in-state) $30,708 (out-of-state)	PhD: $58,720 Doctor of Engineering: $65,000
Population description	Historical black institution (minority – 80%)	Predominantly white (minority – less than 30%)	Predominantly white (minority – less than 30%)
Current program Description	D. Eng in Civil Engineering	Ph.D. in Civil Engineering	Ph.D. in Civil and Systems Engineering
Focus Areas	1. Structural Engineering, 2. Geotechnical Engineering, 3. Transportation Engineering, 4. Environmental Engineering, 5.Hydrologic/Hydraulic/Water Resource Engineering, 6. Engineering Construction and Management, 7. Earthquake Engineering	1.Civil Systems 2. Environmental Engineering 3. Geotechnical and Pavement 3. Structure 4. Transportation 5. Project Management 6. Water Resource	1.Structural engineering 2.Structural mechanics 3.Probabilistic methods 4.Hazards management 5.Systems engineering

Although UM-CP and JHU are classified as R1 institutions with a very high level of both research activity and per capita in such research activity, the CE program at MSU has demonstrated tremendous research capabilities with a lot of resources including facilities and a lot of outstanding faculty conducting research. There has been reported a 200% increase in funded projects at both the federal and state levels and better assistance opportunities to doctoral students provided through external and supplemental funding for CE doctoral students at MSU.

Table D2. Similarities with similar programs

Language/Communication Testing and Placement	All D.Eng/Ph.D. students without a prior degree from an English-speaking university must take an English Language Assessment.
Determination of Permanent Advisor	Students are required to work with a specific advisor based on his or her research interests.
Qualifying Examination (QE)	All students studying for D.Eng students at MSU or Ph.D. students at JHU or UMD-CP must take the QE before candidacy.
Reviews of all Ph.D. students in Civil Engineering	Reviews of D.Eng students at MSU or Ph.D. students at JHU or UMD-CP are performed annually
Ph.D. Thesis Committee	Every D.Eng student at MSU or Ph.D. student at JHU or UMD-CP must have a Thesis Committee of at least 4 or 5 faculty members.
Dissertation Defense	Dissertation Defense which is the final examination before the conferral of the Ph.D. degree is undertaken alike by these universities

D.2. Justification for Proposed Program

There are two Ph.D. programs in Civil Engineering in the State of Maryland, and there is a great need for professionals in this space as supported by the data provided in the aforementioned sections.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

To date, there are no equivalent programs at any of the State's HBIs, including Bowie State University, Coppin State University, and the University of Maryland Eastern Shore (UMES). The Ph.D. program in Sustainable and Resilient Infrastructure Engineering will not have any negative impact on the State's HBIs. Furthermore, this program will enhance Morgan's reputation across the country as an HBI since there is a need nationwide for such a program and will benefit Morgan State University substantially.

F. Relevance to the identity of Historically Black Institutions (HBIs)

Morgan is the largest and most comprehensive of the State's four HBIs. In 2017, Morgan was designated by the General assembly as Maryland's Preeminent Public Urban Research University. Morgan was also elevated from a Carnegie research classification to a high-research classification in 2018. Roughly 80% of Morgan's undergraduate and graduate student populations are African-American. Morgan is committed to the academic success and achievement of all students. None of the other HBIs have a Ph.D. program in Sustainable and Resilient Infrastructure Engineering or similar. For reasons previously discussed, the proposed Program is essential to supporting Morgan's mission and identity as an HBI.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes

G.1. Overview

G.1.1. Program Establishment

This program is well-aligned with the vision established by Dr. David Wilson, President of Morgan State University, and Provost Hongtao Yu. In addition, Dr. Oscar Barton, Dean of the Clarence M. Mitchell, Jr. School of Engineering, encouraged the establishment of this program and is enthusiastically supportive. The Program builds upon the undergraduate courses offered within the Department of Civil Engineering and encompasses the research expertise/capabilities and graduate courses taught by the Civil Engineering faculty. It leverages most of the existing courses within the Doctor of Engineering program and introduces new courses designed to integrate knowledge and research across the various domains of engineered systems of urban infrastructure. The Program will be offered by the Department of Civil Engineering.

G.1.2 Program Oversight

The CE Graduate Coordinator will oversee the Program with duties such as reporting to the CE Department Chair, scheduling graduate classes, data gathering, program assessment, registration, retention, and advocacy.

G.2. Educational Objectives and Learning Outcomes

G.2.1. Program Objectives

The Program targets highly motivated students who have already obtained the Bachelor's or Master's degree and desire to seek career opportunities in education, consulting, research, or administration to name a few.

G.2.2. Expected Student Learning Outcomes

Upon completion of the Program, students will have gained a broad technical and interdisciplinary background that will enhance their ability to identify and tackle critical infrastructure, environmental, and …. Specifically, upon completing the Program, students will be expected to:

1. Demonstrate a breadth of knowledge in a chosen Sustainable and Resilient Infrastructure Engineering concentration;
2. Apply advanced mathematics, theory, principles of engineering, planning, and/or management in solving complex civil infrastructure problems;
3. Design independently and execute high-level research; and
4. Communicate effectively both orally and in written form and function on an interdisciplinary team, particularly in a laboratory setting.

G.3. Program Evaluation

Explain how the institution will provide for assessment of student achievement of learning outcomes in the program, and document student achievement of learning outcomes in the program. This section is not applicable to this program.

G.4. Course Descriptions & Program Requirements

G.4.1. Admission Requirements

Outstanding students with a cumulative GPA of 3.0 (on a scale of 4.0) and above in approved Master's Degree

Programs (Table G3) will be considered for admission. The Program also welcomes exceptional students from related disciplines with at least a 3.3 cumulative GPA for all graduate and undergraduate work completed and a commitment to innovation and leadership. Other requirements include a resume or curriculum vitae documenting current and previous professional activities, planned career goals, a statement of research interest (not to exceed 500 words), and three letters of recommendation from professors or supervisors familiar with the applicant's academic/professional background. All application materials must be sent directly to the School of Graduate Studies for preliminary screening. Acceptance into the School of Graduate Studies is a prerequisite for admission into the Program.

G.4.2. General Requirements

Students enrolled in the Program will be required to satisfy the following requirements:

1. Form a doctoral advisory committee of four members, among whom at least three of them should be tenured or tenure-track faculty members. The chair of the committee must be a member of the graduate faculty and the CE department. A minimum of two CE faculty members must serve on the committee. The committee should be formed no sooner than the end of the first year, and no later than the end of the third year of enrollment, that will approve the student's program of study and guide the student's research activities.
2. Complete a minimum of 36 graduate credit hours (including 15 hours of dissertation-related research) of study beyond the master's degree or complete a minimum of 60 graduate credit hours (including 15 hours of dissertation-related research) of study beyond the bachelor's degree.
3. Pass a written qualifying exam within the first two years of study (one attempt must be taken within the first year), doctoral candidacy examinations (no sooner than a year after passing the qualifying exam), administered by the dissertation committee, on the core subjects and declared concentration.
4. Develop and defend a dissertation proposal within the first four years of admission; and
5. Complete and successfully defend a dissertation based on timely and original research in a relevant area of Sustainable and Resilient Infrastructure Engineering within the six years of matriculation.
6. The original contribution of the dissertation work must be determined by the dissertation committee chair.

   To maintain good academic standing and remain in the Program, the student may not have more than two "C" course grades and must maintain a cumulative GPA of 3.0. Failure to meet these requirements will lead to academic probation for one academic year.

G.4.3. Program of Study

The required minimum coursework for the Ph.D. degree in Sustainable and Resilient Infrastructure Engineering is 60 graduate credits beyond the Bachelor's degree and 36 graduate credits beyond the Master's degree. Up to four courses (not to exceed 12 credits) for the B.S.-to-Ph.D. path and two courses (not to exceed 6 credits) for the M.S.- to-Ph.D. path, respectively, from other accredited institutions may be accepted for transfer towards the Ph.D. degree after departmental review and approval for course equivalency. Transfer courses cannot be used if they satisfy the academic requirements of an awarded degree for the former program. Transfer courses at a grade of B or above are required.

Table G1: Credit breakdown for students pursuing a Ph.D. directly from a bachelor's degree (60 credits required beyond a bachelor's degree). Note: *At least nine credits of the elective courses from the same track are required for a concentration

Foundation Elective Courses (8)	24 credits*
Research courses (5)	15 credits
Graduate Seminar (1)	3 credits
Dissertation Research (5)	15 credits
Dissertation Defense (1)	3 credits
Total	**60 credits**

Table G2: Credit breakdown for students pursuing a Ph.D. Degree directly from Master's Degree (36 credits required beyond a Master's Degree). Note: * The nine credits of the elective courses from the same track are required for a concentration.

Foundation Elective Courses (3)	9 credits *
Research Courses (2)	6 credits
Graduate Seminar (1)	3 credits
Dissertation Research (5)	15 credits
Dissertation Defense (1)	3 credits
Total	**36 credits**

Table G3: List of approved Master's Degree programs for admission to the Ph.D. program

Masters in Engineering
Masters of Science Civil Engineering
Masters of Science Environmental Engineering

Students with a master's degree in the approved areas listed in Table G3 or a related discipline will be required to take a minimum of 36 graduate credits, including 9 credits of Foundation Elective, 6 credits of Research Courses, 3 credits of Graduate Seminar, 15 credits of Dissertation Research, and 3 credits of Dissertation Defense. Students who only have a bachelor's degree or who do not have a master's degree in the approved degree program listed in Table G3 will be required to take a minimum of 60 graduate credits, including 24 credits of Foundation Elective Courses, 15 credits of Research Courses, 3 credits of Graduate Seminar, 15 credits of Dissertation Research, and 3 credits of Dissertation Defense. Students in the B.S. to Ph.D. track will receive an *en passant*, or "along-the-way," master's degree, Master of Science in Engineering after completing 30 credits in the program. These 30 credits must include 24 credits of Foundation Elective Courses. Students are limited to a maximum of three 500-level courses. Example foundation elective topical areas may relate to, but are not limited to, listed in Section 4.5. Students can also have outside elective courses as approved by the Program Director.

Table G4: Research Courses

Course Number	Course Title	Credits
CEGR 805	Pre-Candidacy Research I	3.0
CEGR 810	Pre-Candidacy Research III	3.0
CEGR 815	Pre-Candidacy Research IV	3.0
CEGR 820	Pre-Candidacy Research IV	3.0
CEGR 825	Pre-Candidacy Research V	3.0

Table G5: Dissertation Research Courses

Course Number	Course Title	Credits
CEGR 905	Dissertation Research I	3.0
CEGR 910	Dissertation Research II	3.0
CEGR 915	Dissertation Research III	3.0
CEGR 920	Dissertation Research IV	3.0
CEGR 925	Dissertation Research V	3.0
CEGR 997/998	Dissertation Guidance/Defense	3.0

Note that the student is eligible to take the Dissertation Research courses listed in Table G5 only after he/she has passed the Dissertation Proposal Exam (A), and been 'Advanced to Candidacy'. Prior to this the Research courses in Table I must be used. A student who has completed all required course credits, but who has not 'Advanced to Candidacy', should register for the CEGR 993 (Pre-Candidacy course). Doctoral students are expected to complete at least three articles for publication, of which one is either accepted or published in a journal (approved by the doctoral committee) and two are submitted as a conference or a journal paper before completion of their program, and they will finish the Ph.D. program with CEGR 997/998 (Dissertation Guidance/Defense). In Table G4, the five research courses (CEGR 805 - CEGR 825) are equivalent to the research courses CEGR 790 and CEGR 791 in the catalog of the DEng program.

Residency Requirements

All candidates must satisfy eighteen (18) credit hours of residency requirements in one of the following ways: enrolling in nine credit hours per semester for two consecutive semesters or part-time candidates must register for six credit hours per semester for three consecutive semesters.

Upon achieving Doctoral Candidacy, the student will continuously register in Fall and Spring terms for CEGR 997 (Dissertation Guidance) until the Dissertation is completed and submitted to the School of Graduate Studies for review. The course is used only when the curriculum has been completed, candidacy has been achieved, and the student is completing the research and writing of the Dissertation. The CEGR 997 course registration maintains the student status as a matriculated, full-time student (student is registered for 3 credit hours and the system reports a full-time 9 credit hour load).

After the Intent to Defend the Dissertation form has been received by the School of Graduate Studies, this course registration will be changed to CEGR 998 (Dissertation Defense) for the given semester and count for 3 credit hours of curricular coursework (CEGR 998 will also count as 9 credits of load). CEGR 997 will not count toward curricular credits. Other courses cannot be substituted for CEGR 997 (Dissertation Guidance). The only eligible grade for CEGR 997 (Dissertation Guidance) is the grade of "S" and the only acceptable grade for CEGR 998 (Dissertation Defense) is "P/F" (Pass/Fail).

G.4.4. Example Plans of Study

Below are two examples of a plan of study for a Ph.D. in SRIE

***Plan I**: For students holding only a bachelor's degree pursuing a Ph.D. in SRIE (60 credits)*

		First Semester	Credits		Second Semester	Credits
YEAR 1	CEGR 787	GRADUATE SEMINAR	3	CEGR 805	RESEARCH COURSE	3
	CEGR xxx	FOUNDATION ELECTIVE COURSE	3	CEGR xxx	FOUNDATION ELECTIVE COURSE	3
	CEGR xxx	FOUNDATION ELECTIVE COURSE	3	CEGR xxx	FOUNDATION ELECTIVE COURSE	3
	TOTAL		**9**	**TOTAL**		**9**
YEAR 2	CEGR xxx	FOUNDATION ELECTIVE COURSE	3	CEGR xxx	FOUNDATION ELECTIVE COURSE	3
	CEGR xxx	FOUNDATION ELECTIVE COURSE	3	CEGR xxx	FOUNDATION ELECTIVE COURSE	3
	CEGR 810	RESEARCH COURSE	3	CEGR 815	RESEARCH COURSE	3
		TAKE QUALIFYING EXAM				
	TOTAL		**9**	**TOTAL**		**9**
		After successful completion of all credits, the student is awarded the en Passant Master's degree				
YEAR 3	CEGR 820	RESEARCH COURSE	3	CEGR 910	DISSERTATION RESEARCH	3
	CEGR 825	RESEARCH COURSE	3	CEGR 915	DISSERTATION RESEARCH	3
	CEGR 905	DISSERTATION RESEARCH	3	CEGR 920	DISSERTATION RESEARCH	3
		SUBMIT PAPER # 1			*SUBMIT PAPER # 2*	
		CANDIDACY PROPOSAL EXAM (A)				
	TOTAL		**9**	**TOTAL**		**9**
YEAR 4	CEGR 925	DISSERTATION RESEARCH	3	CEGR 998	DISSERTATION DEFENSE	3
	CEGR 997	DISSERTATION GUIDANCE	0		***DISSERTATION DEFENSE EXAM (B)***	
		SUBMIT PAPER # 3			COMPLETE & SUBMIT DISSERTATION	
	TOTAL		**3**	**TOTAL**		**3**
		BS –> PhD, SRIE			**TOTAL CREDIT HOURS**	**60**

Table G6: A 60-credit plan for students with a bachelor's degree pursuing a Ph.D. in SRIE

First Semester (9 Credits)

- Graduate Seminar 3 credits
- Foundation Elective Course 6 credits

Second Semester (9 Credits)

- Foundation Elective Course 6 credits
- Research Course 3 credits

Third Semester (9 Credits)

- Foundation Elective Course 6 credits
- Research Course 3 credits
- *Take Qualifying Exam (Q Exam)*

Fourth Semester (9 Credits)

- Foundation Elective Course 6 credits
- Research Courses 3 credits

Fifth Semester (9 Credits)

- Research Courses 6 credits
- Dissertation Research 3 credits
- *Take Candidacy Exam (A Exam)*

Sixth Semester (9 Credits)

- Dissertation Research 9 credits

Seventh Semester (3 Credits)

- Dissertation Research 3 credits

Eighth Semester (3 credits)

- Dissertation Defense (B Exam) 3 credits

Total Credits = 60

***Plan II**: For students with a master's degree pursuing a Ph.D. in SRIE (36 credits)*

		First Semester	Credits		Second Semester	Credits
YEAR 1	CEGR 787	GRADUATE SEMINAR	3	CEGR xxx	FOUNDATION ELECTIVE *or* RESEARCH COURSE	3
	CEGR xxx	FOUNDATION ELECTIVE *or* RESEARCH COURSE	3	CEGR 805	RESEARCH COURSE *SUBMIT PAPER # 1*	3
	CEGR xxx	FOUNDATION ELECTIVE *or* RESEARCH COURSE	3	CEGR 810	RESEARCH COURSE	3
		TAKE QUALIFYING EXAM			***CANDIDACY PROPOSAL EXAM (A)***	
	TOTAL		**9**	**TOTAL**		**9**
YEAR 2	CEGR 905	DISSERTATION RESEARCH	3	CEGR 920	DISSERTATION RESEARCH	3
	CEGR 910	DISSERTATION RESEARCH	3	CEGR 925	DISSERTATION RESEARCH	3
	CEGR 915	DISSERTATION RESEARCH	3		*SUBMIT PAPER # 3*	
		SUBMIT PAPER # 2				
	TOTAL		**9**	**TOTAL**		**6**
YEAR 3	CEGR 997/998	DISSERTATION GUIDANCE/DEFENSE	3 / 9			
		DISSERTATION DEFENSE EXAM (B)				
		COMPLETE & SUBMIT DISSERTATION				
	TOTAL		**3**			
		MS –> Ph.D., ENGINEERING			**TOTAL CREDIT HOURS**	**36**

Table G7: A 36-credit plan for students with an approved Master's degree pursuing a Ph.D. in SRIE

First Semester (9 Credits)

- Graduate Seminar 3 credits
- Foundation Elective/Research Course 6 credits
- *Take Qualifying Exam (Q Exam)**

Second Semester (9 Credits)

- Foundation Elective/Research Course 3 credits
- Research Course 6 credits
- *Take Candidacy Proposal Exam A**

Third Semester (9 Credits)

- Dissertation Research 9 credits

Fourth Semester (6 Credits)

- Dissertation Research 6 credits

Fifth Semester (3 Credits)

- Dissertation Guidance/Defense 3 credits
- *Take Dissertation Defense Exam B*

Total Credits = 36

Residency Requirements All candidates must satisfy 18 credit hours of residency requirements in one of the following ways: Full-time candidates for the Ph.D. degree in SRIE must satisfy residency requirements by enrolling in nine (9) credit hours per semester, for two (2) consecutive semesters. Part-time candidates for the Ph.D. degree in SRIE must satisfy residency requirements by enrolling in six (6) credit hours per semester, for three (3) consecutive semesters.

Upon completion of course requirements and all required examinations, the candidate must continue to register for "Dissertation Guidance" each semester until the dissertation is successfully completed.

G.4.5. Course Descriptions

CEGR 510: Principles of Environmental Engineering I **Three Hours: 3 Credits**
Covers the domains and principles of environmental engineering. Course provides context for advanced understanding of environmentally regulated systems. Review of the interdisciplinary sciences (biological, ecological, physical, and chemical) will focus on transformation processes, transport phenomena, and reactor models for water quality engineering applications and technologies.

CEGR 511: Principles of Environmental Engineering II **Three Hours: 3 Credits**
A continuation of CEGR 510 and covers topics such as advanced water and wastewater treatment, air quality engineering, integrated solid waste management, hazardous waste management, site assessment, remediation technologies, and environmental health and safety.

CEGR 512: Principles of Environmental Engineering III **Three Hours: 3 Credits**
The course covers basic concepts in environmental engineering design not covered in CEGR 510 and CEGR 511 and covering topics such as urban sustainable systems, bioremediation, and environmental modeling and simulation (water, groundwater, stormwater, and air).

CEGR 513: Environmental Chemistry and Microbiology **Three Hours: 3 Credits**
Chemical laboratory work includes analyses of turgidity, color, pH, acidity, alkalinity, and hardness, etc.; and instrumental methods using high pressure liquid chromatography, gas chromatography, and atomic absorption, etc. The microbiological analyses include uses and functions of the microscope, multiple- tube and membrane filter techniques. The laboratory analyses are covered independently from the lecture. The lecture covers combustion chemistry, chemistry of the anaerobic process, and atmospheric chemistry.

CEGR 514: Environmental Impact and Risk Assessment **Three Hours: 3 Credits**
The course covers strategies and methodologies that have been used to assess the impact of engineering projects. These include technology to assess the impact on air, surface water, and ground water quality, and on land use of transportation facilities, water supply and pollution control facilities, and industrial and community development.

CEGR 531: Reliability Analysis for Infrastructure and Environmental Systems **Three Hours: 3 Credits**
Systems reliability and reliability analysis. Includes measures of reliability, reliability index, correlation coefficient, influence, reliability bounds, Point Estimate Method, Monte Carlo Simulation and others.

CEGR 533: Matrix Structural Analysis **Three Hours: 3 Credits**
Review of statically determinate and indeterminate structures. Degrees of freedom of a structure. Force-Displacement relations for axial load, shear force and bending moment. Euler-Bernoulli beam element. Analytical basis for Force and Displacement Methods of Structural Analysis. Introduction to the Stiffness Method for structural systems. Application of Stiffness Method for trusses, beams and frames. Stepwise development of a computer program to compute nodal displacements and member forces.

CEGR 590 Smart Material Systems **Three Hours: 3 Credits**
An introduction to the principles and applications of various sensor, actuator and functionality of smart materials and structures in order to monitor their state of health, automatically heal internal fractures and

adapt to environmental changes to reduce maintenance cost and increase life span. Constitutive modeling of piezoelectric materials, electroactive polymers, shape memory alloys, and system modeling for the analysis, design, and control of smart material systems.

CEGR 610 - Stormwater Management **Three Hours: 3 Credits**
This course covers fundamental concepts of stormwater management. The class is provided on the engineering and regulatory aspects of stormwater management to address quality and quantity, receiving water problems and sources of pollutants, selection and design of controls and regulations. This course focuses on the proper design, construction and maintenance of various stormwater BMPs, a number of actual constructed systems to support their feasibility and applicability in different development settings.

CEGR 611 – Hydrologic Modeling **Three Hours: 3 Credits**
The class will discuss functionality, accessibility, characteristics and components in the quantity analysis of the hydrological design models. It will cover the basic theories of hydrologic modeling concepts. This course includes computing requirements, data preparation, boundary conditions, model components, model verification, model optimization, forecasting streamflow, depth-area reduction, assessing model uncertainty, erosion and sediment transport, and water quality.

CEGR 612 – Stormwater Modeling **Three Hours: 3 Credits**
This course is an introduction to simulation modeling of river analysis system and stormwater management model. The river analysis system will cover flood areas, embankment and protection work design, river restoration, emergency plans for dam break, optimization of hydraulic work and risk assessment and management. The stormwater management model will cover planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems.

CEGR 613: Physical-Chemical Treatment of Waste and Wastewater I **Three Hours: 3 Credits**
This course covers topics in physical-chemical treatment of water and wastewater and advanced topics in unit operations, flow measurements and water quality equalization; pumping; screening, settling, and flotation; mixing and flocculation; filtration and aeration, absorption, and stripping.

CEGR 614: Physical-Chemical Treatment of Waste and Wastewater II **Three Hours: 3 Credits**
This course covers areas of the physical-chemical treatment of water and wastewater not covered in CEGR 613 and includes the unit operations of carbon absorption and membrane processes and the unit processes of water softening and removal of nitrogen and phosphorous, fluoridation and defluoridation, iron exchange, and disinfection.

CEGR 615: Open Channel Hydraulics **Three Hours: 3 Credits**
This course covers basic principles and energy and momentum equations, uniform flow, gradually varied flow, and spatially and rapidly varied flow. A software project will be required for submission at the end of the course.

CEGR 616: Biochemical Processes in Environmental Engineering **Three Hours: 3 Credits**
This course covers the basic fundamental principles of biochemical processes in environmental engineering systems. Basic concepts in biochemical processes, qualitative tools for describing stoichiometry and energetics of biochemical reactions, qualitative tools for enzymatic kinetics and the principle of mass balance in the analysis of biochemical reactors are presented.

CEGR 617: Advanced Biochemical Processes in Environmental Engineering **Three Hours: 3 Credits**
This is an advanced course in biochemical process engineering application in environmental quality control. It covers in depth application of the principles of biochemical system in the treatment of water, wastewater and biodegradation of hazardous chemicals in the environment.

CEGR 619: Modeling of Groundwater Flow **Three Hours: 3 Credits**
Numerical solutions of the groundwater flow equations (Partial Differential Equations). Emphasis on learning methodology and the use of groundwater flow models such as MODFLOW, FLOW PATH AND SEETRAN.

CEGR 620: Modeling of Groundwater Pollutant Transport **Three Hours: 3 Credits**
Numerical and analytical solutions of the advection dispersion equation. Emphasis on learning method- ology and the use of groundwater models in contaminants and transport such as MT3D, RT3D and MODFLOW.

CEGR 623: Hydrodynamics **Three Hours: 3 Credits**
This course covers fundamental concepts of dynamics of surface water flow, analysis and characteristics of flow in open channels, flow and channel design with consideration of various types of flow, methods and application of flow measuring devices, and problem solving.

CEGR 624: Hydrostatistics **Three Hours: 3 Credits**
Introduction to hydrostatistical data estimation using the concepts of variograms, multivariate techniques, correlation analysis, and linear multiple linear regression. Introduction to some stochastic hydrologic models.

CEGR 625: Modeling of Surface Water **Three Hours: 3 Credits**
This course emphasizes fundamental concepts and theory and methods of modeling surface water flow, establishment of conceptual, physical, mechanical, mathematical models and applications of analytical and numerical solutions to solving engineering problems related to environmental issues.

CEGR 626: Surface Water Hydrology **Three Hours: 3 Credits**
This course emphasizes fundamental concepts of surface water hydrology and physical processes in surface and shallow subsurface water. Through exercises and problem sets, the course introduces students to practical techniques utilized in applied surface water hydrology.

CEGR 627: Introduction to Multiphase Flow **Three Hours: 3 Credits**
This course emphasizes fundamental concepts of theory of multiphase flow including physical processes within multiphase flow, conservation of mass, energy and momentum, constitutive relations of multi- phase flow and analytical solutions for problems related to multiphase flow through porous media.

CEGR 628: Bridge Engineering **Three Hours: 3 Credits**
Historical development of the modern highway bridge; materials; loads and the load path; reinforced concrete bridges; slab, T-Beam and box girders; slab-steel beam bridges, non-composite vs. composite sections; design of continuous steel beam bridges; plate girder bridges; pre-stressed concrete bridges; serviceability; inspection, maintenance and rehabilitation of highway bridges; bridge aesthetics.

CEGR 629: Advanced Structural Steel **Three Hours: 3 Credits**
Advanced design of structural steel elements according to the AISC Load and Resistance Factor Method as applied to advanced topics in steel design. Topics include composite floor systems; bolted and welded connections; beam-column connections; base plates, conventional and innovative lateral load resisting systems for seismic loading as well as application of high strength steel and designing of hybrid steel sections.

CEGR 630: Finite Element Analysis **Three Hours: 3 Credits**
Approximation techniques; Introduction to the Finite Element Method; weighing functions; Galerkin formulation; 1-d and 2-d finite elements; coordinate systems; field problems-irrotational flow, heat transfer; structural and solid mechanics, axial force member, theory of elasticity; linear and quadratic elements, element shape functions; isoparametric elements; Software platform ANSYS 5.3.

CEGR 631: Structural Dynamics **Three Hours: 3 Credits**
Free and forced vibrations of damped and undamped, single-degree-of-freedom and multidegree-of- freedom systems. Langrange's equations; transient and steady-state vibrations; eigenvalue analysis for natural frequencies and normal modes; analysis and stability of structural components (including beams, cables and large systems inshore, offshore, and in space). Time-domain vs. frequency domain analysis; classical approximate methods, Rayleigh method, Dunkerley's equation, Rayleigh Ritz Method, Myklestad's Method for beams; introduction to random vibrations.

CEGR 634: Prestressed Concrete Design **Three Hours: 3 Credits**
Study of prestressing methods (Pre-tensioning and post-tensioning techniques) including strength and load-balancing approaches and their application to the analysis and design of beams, slabs, and axially loaded members. The course discusses properties of concrete and prestressing steels and topics include PCI and ACI design criteria. Anchorage-zone analysis and design for flexure, shear, torsion, camber and study of deflection and time-dependent losses

CEGR 635: Advanced Reinforced Concrete Design **Three Hours: 3 Credits**
This course utilizes the mechanics of concrete and structural design principles to enable students to perform advanced design of reinforced concrete structures. It emphasizes the design for torsion, shear and shear friction, and teaches how to perform the design of two-way slabs, walls, reinforcement at joints, multistory columns and concrete building systems in accordance with the latest building code.

CEGR 636: Artificial Neural Networks I **Three Hours: 3 Credits**
This course provides graduate students and engineering professionals with the fundamentals of Artificial Neural Networks. This course covers neural network architectures, algorithms, and applications. A wide variety of standard neural networks and training algorithms are covered in relationship to logic functions and other applications. Emphasis is on computational characteristics to illustrate similarities and differences among neural networks.

CEGR 638: Artificial Neural Networks II **Three Hours: 3 Credits**
This is a computational course and applies object oriented methodology to programming artificial neural networks. Knowledge gained from this course will enable students to perform advanced application and research in Civil Engineering. Topics to be discussed include pattern class, link-list class, neural network base classes, adaline network, back propagation neural network, self-organizing neural network, and bi- directional associative memory.

CEGR 645: Construct Project Administration and Management **Three Hours: 3 Credits**
This course will teach the applications of the fundamentals of construction management in construction practice and teach the students the responsibilities and risks that are encountered in the construction industry in equipment and material utilization, costing, quality, productivity and safety in construction practice.

CEGR 646: Construction Engineering and Management for Engineering **Three Hours: 3 Credits**
This course will teach the students how the construction industry worldwide works and cover such areas as feasibility studies; organization for construction; financing and cost accounting for construction; design and engineering contracts and procedures; construction contracts; change orders and delays; acceleration; claims, arbitration, mediation, litigation; labor management; project planning.

CEGR 651: Computer Aided Highway Engineering Design **Three Hours: 3 Credits**
This course covers the operational, geometric and hydraulic design of highways to achieve safe and efficient vehicle operation under the conditions of uninterrupted flow.

CEGR 655: Traffic Engineering I **Three Hours: 3 Credits**
The principles of traffic engineering involving the analysis, planning and design of loads, streets and highways, and their related networks. Coverage includes the dynamics of traffic flows, traffic studies, and data collection; capacity analysis of freeways and arteries; the analysis and design of traffic control systems, including signalized and unsignalized intersections.

CEGR 656: Transportation Models and Simulation Analysis I **Three Hours: 3 Credits**
The theory, development, and application of modeling systems commonly used in planning, engineering and operational analysis of transportation systems. The application and calibration of an existing transportation modeling system.

CEGR 657: Advanced Topics in Traffic Engineering **Three Hours: 3 Credits**
Theory, analysis and design of coordinated traffic signal systems, traffic information systems and traffic

management emphasizing area wide optimization, intermodal coordination and incident management.

CEGR 659: Pavement Analysis and Design **Three Hours: 3 Credits**
The analysis of pavement loading and the response of flexible and rigid pavements to loads. The design of pavements to achieve the desired performance and reliability. The management of pavement to optimize life-cycle performance.

CEGR 661: Airport Planning and Engineering **Three Hours: 3 Credits**
The planning and design of airports and their supportive infrastructural systems. The operational analysis of airports and the environmental considerations in their location, design, expansion, and operation.

CEGR 663: Readings in Environmental Engineering **Three Hours: 3 Credits**
This course is required to prepare students in doctoral dissertation. Selected topics from the current literature will include water and waste, air pollution, solid waste, hazardous wastes, ground water hydrology, hydraulics, etc.

CEGR 665: Random Vibrations and Nonlinear Dynamics **Three Hours: 3 Credits**
Review of linear systems. Time Domain vs. Frequency Domain approaches. Introduction to Nonlinear Systems. Phase Plane representation. Existence and Stability using Averaging methods. Random Vibrations. Response of SDOF and MDOF systems subjected to random excitation.

CEGR 670: Special Topics in Highway Safety **Three Hours: 3 Credits**
This is an elective course which discusses highway safety and design issues. The design of horizontal and vertical alignments as well as transition curves is covered. The causes of highway accidents and their relations to highway design elements such as side slope, roadway width, and sight distance, as well as to human elements are thoroughly investigated. Analysis of high accident locations, accident reducing measures, and highway economics is also covered. Students are expected to complete a course project in the broad area of highway safety and design.

CEGR 671: Traffic Flow Theory **Three Hours: 3 Credits**
Advanced topics in traffic flow theory for non-interrupted and interrupted flows. Topics include speed flow and density; shock waves in traffic streams; gap acceptance. Queuing theory and probabilistic processes as applied in the analysis of interrupted traffic flows. Applications in highway, traffic signals and terminal systems design.

CEGR 673: Advanced Environmental Engineering Design **Three Hours: 3 Credits**
Covers basic parameters and elements in planning, development of design parameters, conceptual design, hydraulic and/ or pneumatic profiles, innovation, cost, and financing. Possible topics included water treatment systems, wastewater treatment, stormwater management systems, air pollution controls, site remediation technologies, etc. This course is a design course that involves real-life projects that the students have selected from the proceeding list of topics and approved by the instructor.

CEGR 680: Highway Infrastructure Management Systems **Three Hours: 3 Credits**
This course deals with the development of computerized maintenance management systems for the integrated management of transportation infrastructures. It addresses the requirements of Government Accounting Standard Board (GASB) Statement 34, required to be followed on transportation maintenance projects. Modeling and management of highway maintenance, bridge maintenance, and pavement maintenance are discussed. Depreciation of highway assets over time and correlation between highway maintenance and infrastructure security are covered.

CEGR 681: Theory of Traffic Flow **Three Hours: 3 Credits**
Study and evaluation of various qualitative descriptions of the complex phenomenon of traffic flow. The concept and mathematical models considered are statistical relationships, car-following analogy, queuing theory, traffic-network analysis, computing machine simulation studies, mathematical experiments, and distribution-function theories.

CEGR 684: Advanced Algorithms in Transportation I **Three Hours: 3 Credits**
An introduction to graphs and networks, their properties and values in systems analysis, identification and formulation of standard problems, and basic techniques available to solve them. Spanning trees, shortest paths, traveling salesman problem, routing and scheduling, facility location problems, flow problems, covers and matchings. Applications and decision analysis. Emphasis on problem identification, use of computer packages, and the relationship of network properties to solution efforts.

CEGR 685: Advanced Algorithms in Transportation II **Three Hours: 3 Credits**
This is an advanced level transportation engineering course focusing on development and applications of various algorithms in transportation problem solving. It involves modeling and analysis of transportation network problems through the design, analysis, and implementation of algorithms. Emphasis is placed on the use of quantitative techniques of operations research to model system performance.

CEGR 686: Demand Analysis and Forecasting **Three Hours: 3 Credits**
Analysis and forecasting of demand for facilities and services, for use in the planning, design, and operations of transportation systems. Emphasis on the collection and analysis of survey data for demand model development. Covers alternative sample designs, individual choice theories, probabilistic discrete choice models, estimation of desegregate and aggregate models, aggregate forecasting methods and simulation. Illustrated with applications from the field of transportation planning. Hands on exercises in the use of PC statistical analysis software.

CEGR 687: Ground Water Hydrology **Three Hours: 3 Credits**
Theory of ground water movement, storage exploration, and pumping tests. Design of ground water recovery and recharge systems.

CEGR 688: Advanced Mechanics of Solids **Three Hours: 3 Credits**
Mechanical response of materials, including elastic, plastic and viscoelastic components. Continuum mechanics; kinematics of deformation, analysis of states of stress and strain, conservation of mass, balance of momentum and energy, constitutive equations. Discussion of applications including stress concentrations at defects, metal processing, and composite materials.

CEGR 690: Adaptive Structures **Three Hours: 3 Credits**
Behavior of engineering structures subject to induced internal deformations. Transduction devices and adaptive physical systems. Excitation and response of adaptive structures. Actuator placement and static control. Extension to the dynamic case and active vibration control.

CEGR 691: Spacecraft Dynamics and Control **Three Hours: 3 Credits**
Altitude dynamics and control of spacecraft. Overview of spacecraft systems and orbit determination. Rigid body kinematics and dynamics, and linear control concepts. Active and passive stabilization of spacecraft. Altitude control subsystems and hardware components, and design technology. Illustrations with available real examples and applications.

CEGR 692: Theory of Elastics **Three Hours: 3 Credits**
This course presents the continuum concepts of stress, stress boundary conditions, principal stresses and the equations of equilibrium; Generalized Hook's law; Small strain theory and principal strains; Plane problems; Stress functions; Saint Venant torsion and flexure; Introduction to three-dimensional problems; Thermoelasticity; Anisotropic solutions.

CEGR 695: Discrete-Time Control Engineering **Three Hours: 3 Credits**
Design of controllers for discrete-time systems, with emphasis on linear sampled-data control. Single- loop digital controllers. Discrete-time state space design. Discrete-time optimal control. Realization of microcomputer real-time control systems. Design problems and applications with hands-on experience.

CEGR 697: Geographic Information Systems Applications in Transportation **Three Hours: 3 Credits**
Course explores Geographic Information Systems (GIS) applications in transportation (GIS-T). The underlying

concepts in GIS applications as well as advantages of GIS over non-GIS methods will be covered extensively. Students will be introduced to GIS softwares including ArcView GIS, MapObjects, and other relevant GIS tools. Finally, a number of GIS applications in real-world problem solving will be reviewed.

CEGR 702: Seismic Design **Three Hours: 3 Credits**
This course provides for the seismic design of buildings. Dynamic analysis of single and multidegree-of-freedom elastic systems subjected to earthquake motions. Earthquake Design Spectra Analysis. Inelastic dynamic response analysis. Consideration of new building code requirements.

CEGR 703: Geometrically Nonlinear Structural Analysis **Three Hours: 3 Credits**
This course provides a basic background in the theory of geometrically nonlinear structural analysis. Formation of geometric stiffness matrices. Nonlinear analysis of trusses, plane frames, space frames, membrane, and cable net structures. Development of three-dimensional beam-column theory.

CEGR 704: Innovations in Structural Steel Design **Three Hours: 3 Credits**
This course provides for the study of innovations in structural steel design. Ductile design concepts of steel structures and the systematic methods and applications of plastic analysis concepts required to describe the structural behavior associated with ductile design are presented. Design procedures and detailing requirements for ductile braced frames and ductile moment-resisting frames. Consideration of new building code requirements.

CEGR 705: Mechanics of Composite Materials **Three Hours: 3 Credits**
Basic mechanics of composite materials. Stress Strain relationship of orthotropic materials. Introduction to micromechanics. Classical lamination theory. Mechanical behavior of fiber reinforced composite materials. Damage and failure criteria.

CEGR 709: Wave Propagation in Elastic Media **Three Hours: 3 Credits**
Mechanical wave propagation in bounded and unbounded media. Wave reflection and transmission at interfaces and boundaries; stress waves. Additional topics of mutual interest to students and the instructor.

CEGR 723: Advanced Consolidation Theory **Three Hours: 3 Credits**
The fundamentals of soil consolidation theory are addressed in detail. Based on principles of continuum mechanics and constitutive relations, governing equations are derived for the deformation of the saturated skeletal frame. These in turn are tested against laboratory measurements. Unsolved problems in consolidation theory are emphasized.

CEGR 725: Aquifer Mechanics **Three Hours: 3 Credits**
Emphasis on mechanical characteristics of pore flow and skeleton matrix within an aquifer system; motion of pore flow and aquifers, including vertical and horizontal movement of aquifers; interaction between pore flow and skeleton matrix of sedimentary material. Solving Environmental problems related to land subsidence and fissures due to ground fluid (gas, oil and water).

CEGR 726: Geosynthetics **Three Hours: 3 Credits**
This course provides graduate students and engineering professionals with knowledge of geosynthetic materials and methods for application procedures in geotechnical and foundation engineering. Geotextiles, geogrids, geosynthetic clay liners, and geocomposites are among the geosynthetic topics of application and procedures. Designing with geosynthetics, application procedures, and specifications are topics of this course.

CEGR 730: Constitutive Laws in Geomechanics **Three Hours: 3 Credits**
Fundamental concepts of stress and strain tensors, criterion of failures for geomaterials. Theory of elasticity, viscosity, and plasticity, and their combinations such as elasto-viscous, elasto-plastic models in geomechanics for clay and sand soils. Discussion of classic models in geomechanics and their applications to engineering.

CEGR 731: Advanced Soil Mechanics I **Three Hours: 3 Credits**
Mechanics of seepage and groundwater flow. Effect of seepage on stability, uplift, and foundation design. Basic

lateral earth pressure relationships. Stability analysis. Design of breakheads, cofferdams, retaining walls and slopes.

CEGR 737: Continuum Mechanics **Three Hours: 3 Credits**
Emphasis on theoretical study of continuum mechanics including introduction to tensor analysis; analysis of stress and strain tensors; motion and deformation; conservation laws; constitutive laws. Applications to porous material or sedimentary material in geomechanics and geotechnical engineering.

CEGR 738: Boundary Element Method in Geomechanics **Three Hours: 3 Credits**
Theoretical concepts and principles of the Boundary Element Method (BEM) and applications to Geo-mechanics and Geotechnical Engineering. Establishment of conceptual, mathematical, numerical, and mechanical models. Time and spatial discretization. Solution of matrix equations and programming in FORTRAN and C. Applications of BEM to geomaterials which exhibit linear and nonlinear elastic, viscous, and elasto-plastic behavior. Applications of BEM to solve 2D and 3D problems in Geotechnical Engineering.

CEGR 739: Discrete Element Method in Geomechanics **Three Hours: 3 Credits**
Advanced concepts, principles, programming, and applications of the Discrete Element Method (DEM) in Geomechanics and Geotechnical Engineering. Parameter and determination. Contacting laws and constitutive models. Modeling of rigid block and granular materials. Modeling of deformable block and granular materials. Establishment of conceptual, physical, numerical, and mathematical models. Discretization in space and time. Programming for computation and user friendly interfaces in Visual Basic. Applications of the DEM in solving engineering problems.

CEGR 740: Special Topics in Geographic Information Systems **Three Hours: 3 Credits**
Advanced concepts, principles, and applications of GIS are presented and illustrated. Project design, data acquisition, management, analyses, and display/product generation will be emphasized. Applications of GIS methodologies in real world problems from various disciplines will also be presented. Students will be required to complete a GIS project as the final examination grade for the course. ESRI's ARCINFO and ArcView will form the basic GIS software for the course

CEGR 741: Special Course in Remote Sensing **Three Hours: 3 Credits**
Advanced concepts, principles, and applications of RS are presented and illustrated. Project design, data acquisition, management, analyses, and display/product generation will be emphasized. Applications of RS methodologies in real world problems from various disciplines will also be presented. Students will be required to complete a RS project as a final examination grade for the course. ENVI and ERDAS will form the basic GIS software for the course.

CEGR 742: Geographic Information Systems (GIS) Modeling in Raster **Three Hours: 3 Credits**
Advanced geographic information system (GIS) modeling concepts, principles, methodology, and applications are presented and illustrated. Map algebra, pattern recognition, model formulation, implementation and verification, and advanced raster data structures for dynamic modeling will be emphasized. Cross-disciplinary approaches of GIS modeling of real world problems will also be presented. Student will be required to complete a GIS modeling project, make an oral presentation, and submit a written report of their findings as part of the final grade for this course.

CEGR 743: Finite Element Method in Geomechanics **Three Hours: 3 Credits**
Theoretical concepts and principles of the Finite Element Method (FEM) as well as applications to Geomechanics and Geotechnical Engineering. Establishment of conceptual, mathematical, numerical, and mechanical models. Time and spatial discretization. Solution of matrix equations and programming in FORTRAN and C. Applications of FEM to geomaterials which exhibit linear and nonlinear elastic, viscous, elasto-plastic behavior. Applications of FEM to solve 2D and 3D problems in Geotechnical Engineering.

CEGR 744: Tensor Analysis in Geomechanics **Three Hours: 3 Credits**
Concepts, principles of tensors and their applications in Geomechanics. Coordinates and transformation of coordinates. Vectors and tensors, stress and strain tensors in elasticity. Gradient, divergence and rotations,

derivatives of tensors and applications to Geomechanics.

CEGR 745: Advanced Analysis of Slope Stability **Three Hours: 3 Credits**
Study advanced concepts and principles in limit equilibrium theory. Analyze soil and rock slope stability with theoretical approaches as well as numerical methods (e.g., FEM and FDM). Apply the limit equilibrium theory to slope stability. Back analysis and its applications to prediction of potential failure of slope. Slope design and problem solving in Geotechnical and Geological Engineering.

CEGR 746: Advanced Soil Dynamics **Three Hours: 3 Credits**
Emphasis on theoretical and applied study in soil dynamics including soil stress-strain relations, strength and failure under dynamic loading, loading rate effect, small and larger deformation under repeated loading , propagation of stress wave in soils. Investigation of soil dynamic parameters through lab and field. Solving problems in engineering such as sand liquefaction due to earthquake, foundation stability analysis under vibration, wave propagation because of pile driving or earthquake, etc.

CEGR 747: Well Hydraulics **Three Hours: 3 Credits**
This course emphasizes theoretical and applied well hydraulics including steady and unsteady flow toward a well within confined, semi-confined or unconfined aquifers. Analytical solutions of well drawdown, analysis of aquifer parameters through aquifer testing, and applications to water resources exploitation are discussed.

CEGR 748: Design of Pile Foundations **Three Hours: 3 Credits**
Study of theories and principles such as structure characteristics, load transfer mechanics, pile load tests, consolidation settlement of group piles, negative skin friction laterally loaded piles. Design of different types of pile foundations, estimate pile length and installation of piles.

CEGR 749: Earthquake Engineering **Three Hours: 3 Credits**
This course covers seismic wave and its propagation in porous media, analytical and numerical analysis for elastic, plastic and viscous waves, analysis of ground motion and field responses due to an earthquake, soil-structure interaction induced by earthquakes, soil liquefaction and site characterization, geotechnical designs with consideration of seismic forces.

CEGR 750: Advanced Geotechnical Experiments **Three Hours: 3 Credits**
This course emphasizes advanced geotechnical experiments conducted in laboratories and fields, including designing and planning geotechnical tests, introduction to conventional and advanced laboratory and field equipment, data acquisition experiments, and stress analysis for experimental investigation.

CEGR 755: Construction Cost Management **Three Hours: 3 Credits**
This course will teach the students cost estimating concepts as it relates to owner and contractor in the construction industry. Students will acquire the skills to manage and control project costs that would benefit the owner, the contractor and the public at large.

CEGR 756: Advanced Construction Cost Management **Three Hours: 3 Credits**
This course will introduce the student to the advanced construction cost management concepts. It will enhance the student's knowledge of financial analysis and develop competence in advanced construction cost estimation and management.

CEGR 760: Dissertation Research & Writing for Construction Students **Three Hours: 3 Credits**
This course will teach the students topic selection, research planning, data collection and methodology, including the structuring and writing the dissertation.

CEGR 765: Law for Architects, Business, Engineers and Construction Managers **Three Hours: 3 Credits**
This course explores legal concepts related to architects, business, engineers and construction managers. It will encourage students to become conscious of the legal implications of their actions as professionals and how to adapt the legal concepts to day-to-day practice.

CEGR 780: MSU/JHU Engineering Education Study **Two to 6 hours: 2-6 Credits**
This course will facilitate educational exchange between students at Morgan State University and Johns Hopkins University.

CEGR 788: Seminar I **One Hour: 1 Credit**
This is the first part of an advanced seminar course taken during the first two semesters of the Master of Engineering Program in which students from different engineering disciplines (Civil, Electrical, and Industrial Engineering) work together to identify and solve problems.

CEGR 789: Seminar II **One Hour: 1 Credit**
This is the second part of an advanced seminar course taken during the first two semesters of the Master of Engineering Program in which students from different engineering disciplines (Civil, Electrical, and Industrial Engineering) work together to identify and solve problems.

CEGR 793: Project Guidance **Three Hours: 3 Credits**
This course provides a non-thesis student who has not completed their Project Report in the assigned semester, a mechanism for continuing their work under faculty supervision. Although a three credit course, it is reported as a nine credit course to provide full-time status for those students taking fewer than nine credits in a semester.

CEGR 795: Project Report **Three Hours: 3 Credits**
Project Report I provides a student with an opportunity to formulate a proposal for a professional engineering project. The student may work as a project at the University or off-site, under the supervision of a faculty advisor.

CEGR 797: Thesis Guidance **Three Hours: 3 Credits (Reports as 9)**
Thesis guidance provides students, who have not completed their thesis in CEGR 799, a mechanism for continuing work under faculty supervision. Thesis Guidance courses earn "S" grades.

CEGR 799: Thesis Defense **Three Hours: 3 Credits (Reports as 9)**
This is the initial course for students conducting research and writing a thesis under faculty supervision. The grade is "IP" until the thesis is completed and approved. CEGR 797 will be changed to CEGR 799 after thesis is completed. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

CEGR 805 - Pre-Candidacy Research I **Three Hours: 3 Credits**
This course is intended as a rotational research opportunity for students. Students will conduct research driven by the instructor/PI to advance a research objective. The course will work through research issues and solutions utilizing current research projects being undertaken by the faculty. In addition, this course will enable a PhD student to develop a scholarly research plan of heir own in consultation with the student's dissertation committee chairperson. This course aims for the student to experience various research methods/techniques while developing their plan of action for completion of the dissertation

CEGR 810 - Pre-Candidacy Research II **Three Hours: 3 Credits**
This course is intended as a rotational research opportunity for students. Students will conduct research driven by the instructor/PI to advance a research objective. The course will work through research issues and solutions utilizing current research projects being undertaken by the faculty. In addition, this course will enable a PhD student to develop a scholarly research plan of their own in consultation with the student's dissertation committee chairperson. This course aims for the student to experience various research methods/techniques while developing their plan of action for completion of the dissertation.

CEGR 815 - Pre-Candidacy Research III **Three Hours: 3 Credits**
This course is intended as a rotational research opportunity for students. Students will conduct research driven by the instructor/PI to advance a research objective. The course will work through research issues and solutions utilizing current research projects being undertaken by the faculty. In addition, this course will enable a PhD student to develop a scholarly research plan of their own in consultation with the student's dissertation committee chairperson. This course aims for the student to experience various research methods/techniques while developing their plan of action for completion of the dissertation.

CEGR 820 - Pre-Candidacy Research IV **Three Hours: 3 Credits**
This course is intended as a rotational research opportunity for students. Students will conduct research driven by the instructor/PI to advance a research objective. The course will work through research issues and solutions utilizing current research projects being undertaken by the faculty. In addition, this course will enable a PhD student to develop a scholarly research plan of heir own in consultation with the student's dissertation committee chairperson. This course aims for the student to experience various research methods/techniques while developing their plan of action for completion of the dissertation.

CEGR 825 - Pre-Candidacy Research V **Three Hours: 3 Credits**
This course is intended as a rotational research opportunity for students. Students will conduct research driven by the instructor/PI to advance a research objective. The course will work through research issues and solutions utilizing current research projects being undertaken by the faculty. In addition, this course will enable a PhD student to develop a scholarly research plan of their own in consultation with the student's dissertation committee chairperson. This course aims for the student to experience various research methods/techniques while developing their plan of action for completion of the dissertation.

CEGR 905 - Dissertation Research I **Three Hours: 3 Credits**
This course enables a PhD candidate to execute the scholarly research plan (previously developed in the pre-candidacy phase) in consultation with the student's dissertation chairperson and committee. A student can only take this dissertation course after passing the A-Exam and being advanced to candidacy.

CEGR 910 - Dissertation Research II **Three Hours: 3 Credits**
This course enables a PhD candidate to execute the scholarly research plan (previously developed in the pre-candidacy phase) in consultation with the student's dissertation chairperson and committee. A student can only take this dissertation course after passing the A-Exam and being advanced to candidacy.

CEGR 915 - Dissertation Research III **Three Hours: 3 Credits**
This course enables a PhD candidate to execute the scholarly research plan (previously developed in the pre-candidacy phase) in consultation with the student's dissertation chairperson and committee. A student can only take this dissertation course after passing the A-Exam and being advanced to candidacy.

CEGR 920 - Dissertation Research IV **Three Hours: 3 Credits**
This course enables a PhD candidate to execute the scholarly research plan (previously developed in the pre-candidacy phase) in consultation with the student's dissertation chairperson and committee. A student can only take this dissertation course after passing the A-Exam and being advanced to candidacy.

CEGR 925 - Dissertation Research V **Three Hours: 3 Credits**
This course enables a PhD candidate to execute the scholarly research plan (previously developed in the pre-candidacy phase) in consultation with the student's dissertation chairperson and committee. A student can only take this dissertation course after passing the A-Exam and being advanced to candidacy.

CEGR 993 – Pre-Doctoral Candidacy **Three Hours: 3 Credits (Reports as 9)**
This course establishes the student as a full-time student engaged in study prior to the achievement of doctoral candidacy. Students studying for comprehensive examinations or preparing for a proposal defense enroll in this course. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

CEGR 997 – Dissertation Guidance **Three Hours: 3 Credits (Reports as 9)**
Thesis guidance provides students, who have not completed their dissertation in CEGR 998, a mechanism for continuing work under faculty supervision. Dissertation Guidance courses earn "S" grades. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

CEGR 998 – Dissertation Defense **Three Hours: 3 Credits (Reports as 9)**
This is the initial course for students conducting research and writing a dissertation under faculty supervision. The grade is "IP" until the dissertation is completed and approved. CEGR 997 will be changed to CEGR 998 after thesis is completed. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

Core Courses in Concentrations

Structural Engineering (9 credits)
CEGR 628: Bridge Engineering
CEGR 635: Advanced Reinforced Concrete Design
CEGR 629: Advanced Structural Steel

Geotechnical Engineering (9 credits)
CEGR 731: Advanced Soil Mechanics I
CEGR 745: Advanced Analysis of Slope Stability
CEGR 748: Design of Pile Foundation

Transportation Engineering (9 credits)
CEGR 661: Airport Planning and Engineering
CEGR 680: Highway Infrastructure Management System
CEGR 681: Theory of Traffic Flow

Environmental Engineering (9 credits)
CEGR 510: Principles of Environmental Engineering I
CEGR 663: Readings in Environmental Engineering
CEGR 673: Advanced Environmental Engineering Design

Hydrologic/Hydraulic/Water Resource Engineering (9 credits)
CEGR 615: Open Channel Hydraulics
CEGR 619: Modeling of Groundwater Flow
CEGR 687: Ground Water Hydrology

Earthquake Engineering (9 credits)
CEGR 631: Structural Dynamics
CEGR 702: Seismic Design
CEGR 749: Earthquake Engineering

Construction Engineering and Management (9 credits)
CEGR 645: Construct Project Administration and Management
CEGR 646: Construction Engineering and Management for Engineering
CEGR 755: Construction Cost Management

Elective Courses in Concentrations

Structural Engineering
CEGR 590: Smart Material Systems
CEGR 630: Finite Element Analysis
CEGR 631: Structure Dynamics
CEGR 533: Matrix Structural Analysis
CEGR 628: Bridge Engineering
CEGR 629: Advanced Structural Steel
CEGR 634: Prestressed Concrete Design
CEGR 635: Advanced Reinforced Concrete Design
CEGR 665: Random Vibrations and Nonlinear Dynamics
CEGR 690: Adaptive Structures
CEGR 691: Spacecraft Dynamics and Control
CEGR 692: Theory of Elastics
CEGR 695: Concrete-Time Control Engineering
CEGR 702: Seismic Design
CEGR 703: Geometrically Nonlinear Structural Analysis
CEGR 704: Innovations in Structural Steel Design

Geomechanics and Geotechnical Engineering
CEGR 688: Advanced Mechanics of Solids
CEGR 705: Mechanics of Composite Materials
CEGR 709: Wave Propagation in Elastic Media
CEGR 723: Advanced Consolidation Theory
CEGR 725: Aquifer Mechanics
CEGR 726: Geosynthetics
CEGR 730: Constitutive Laws in Geomechanics
CEGR 731: Advanced Soil Mechanics I
CEGR 737: Continuum Mechanics
CEGR 738: Boundary Element Method in Geomechanics
CEGR 739: Discrete Element Method in Geomechanics
CEGR 743: Finite Element Method in Geomechanics
CEGR 744: Tensor Analysis in Geomechanics
CEGR 745: Advanced Analysis of Slope Stability
CEGR 746: Advanced Soil Dynamics
CEGR 748: Design of Pile Foundation
CEGR 749: Earthquake Engineering
CEGR 750: Advanced Geotechnical Experiments

Transportation Engineering
CEGR 651: Computer Aided Highway Engineering Design
CEGR 655: Traffic Engineering I
CEGR 656: Transportation Models and Simulation Analysis I
CEGR 657: Advanced Topics in Traffic Engineering
CEGR 659: Pavement Analysis and Design
CEGR 661: Airport Planning and Engineering
CEGR 670: Special Topics in Highway Safety
CEGR 671: Traffic Flow Theory
CEGR 680: Highway Infrastructure Management System
CEGR 681: Theory of Traffic Flow
CEGR 684: Advanced Algorithms in Transportation I
CEGR 685: Advanced Algorithms in Transportation II
CEGR 686: Demand Analysis and Forecasting
CEGR 697: Geographic Information System Applications in Transportation

Environmental Engineering
CEGR 510: Principles of Environmental Engineering I
CEGR 511: Principles of Environmental Engineering II
CEGR 512: Principles of Environmental Engineering III
CEGR 513: Environmental Chemistry and Microbiology
CEGR 514: Environmental Impact and Risk Assessment
CEGR 531: Reliability Analysis for Infrastructure and Environmental Systems
CEGR 613: Physical-Chemical Treatment of Waste and Wastewater I
CEGR 614: Physical-Chemical Treatment of Waste and Wastewater II
CEGR 616: Biochemical Processes in Environmental Engineering
CEGR 617: Advanced Biochemical Processes in Environmental Engineering
CEGR 663: Readings in Environmental Engineering
CEGR 673: Advanced Environmental Engineering Design

Hydrology/Hydraulic/Water Resources Engineering
CEGR 610: Stormwater Management
CEGR 611: Hydrologic Modeling
CEGR 612: Stormwater Modeling
CEGR 615: Open Channel Hydraulics

CEGR 619: Modeling of Groundwater Flow
CEGR 620: Modeling of Groundwater Pollutant Transportation
CEGR 623: Hydrodynamics
CEGR 624: Hydrostatistics
CEGR 625: Modeling of Surface Water
CEGR 626: Surface Water Hydrology
CEGR 627: Introduction to Multiphase Flow
CEGR 687: Ground Water Hydrology
CEGR 747: Well Hydraulics

Construction Engineering and Management
CEGR 645: Construct Project Administration and Management
CEGR 646: Construction Engineering and Management for Engineering
CEGR 755: Construction Cost Management
CEGR 756: Advanced Construction Cost Management
CEGR 760: Dissertation Research & Writing for Construction Students
CEGR 765: Law for Architects, Business, Engineers and Construction Managers

Other Electives
CEGR 531: Reliability Analysis for Infrastructure and Environmental Systems
CEGR 636: Artificial Neural Networks I
CEGR 638: Artificial Neural Networks II
CEGR 695: Discrete-Time Control Engineering
CEGR 740: Special Topics in Geographic Information System (GIS)
CEGR 741: Special Course in Remote Sensing (RS)
CEGR 742: Geographic Information System (GIS) Modeling in Raster
CEGR 780: MSU/JHU Education Engineering Study
EEGR 505: Advanced Engineering Mathematics with Computational Methods
IEGR 512: Advanced Project Management

G.5. General Education Requirements

General education requirements do not apply to this Program.

G.6. Specialized Accreditation or Graduate Certification Requirements

There are no specialized accreditation or graduate certification requirements for this program and its students.

G.7. Morgan-JHU Memorandum of Understanding

Students will be able to participate in courses related to their program and dissertation research in Sustainable and Resilient Infrastructure Engineering at John Hopkins University (JHU). A copy of the Memorandum of Understanding (MOU) between Morgan and John Hopkins University follows.

G.8. Program Assurances

Morgan provides students with all the necessary information, services, and assistance for success.

Academic Unit	Document
University	University Catalog
School/College	School/College Catalog
Program	Program Handbook, Program Brochure
	Course Description Sheets
	Suggested Curriculum Sequence Sheets
Course	Course Syllabus and Course Outline
Help	Office All kinds of help
Academic Advisor	All kinds of academic advising

Documents in digital form are posted on Morgan website and copies in paper form can be found in the University Library, School/College, and Department Offices.

G.9. Advertising, Recruiting, and Admissions Material

The CE Department has Offices/Services to support Advertising, Recruiting, Admission. Program materials are also provided by the department. These materials are written by the Program faculty members of the Program for distribution. The program will also be advertised in media formats such as ASCE publications, and Chronicles of Higher Education.

H. Adequacy of Articulation

H.1. Articulation with Programs at Partner Institutions

There are no articulation agreements in place.

I. Adequacy of Faculty Resources

I.1. Program Faculty

The Department of Civil Engineering at Morgan State University has distinguished faculty with backgrounds and expertise in construction, geotechnical, structural, environmental, water resources, and transportation engineering. 12 faculty are affiliated with the Program. A list of the faculty is given below.

First Name	Last Name	Appointment Type	Degree/Field	Academic Title/Rank	Status	Expertise
Steve	Efe	Tenure Track	D.Eng./CE	Assistant Professor	Full Time	Structural Engineering
Emad	Gheibi	Lecturer	Ph.D./CE	Lecturer	Full Time	Geotechnical Engineering
James	Hunter	Tenured	Ph.D./CE	Associate Professor	Full Time	Environmental / Water Resources Engineering
Dong Hee	Kang	Tenure-Track	Ph.D./CE	Associate Professor	Full Time	Environmental / Water Resources Engineering
Jiang	Li	Tenured	Ph.D./CE	Professor	Full Time	Geotechnical Engineering / Hydrology/Geo hydrology
Yi	Liu	Tenure Track	D.Eng./CE	Lecturer	Full Time	Geotechnical Engineering / Geohydrology
Gbekeloluwa	Oguntimein	Lecturer	Ph.D./Chem.E	Professor of Practice	Full Time	Environmental Engineering
Simon	Oladele	Lecturer	Ph.D./CE	Lecturer	Full Time	Transportation Engineering
Oludare	Owolabi	Tenure Track	D.Sc../CE	Assistant Professor	Full Time	Geotechnical / Transportation Engineering
Mehdi	Shokouhian	Tenure Track	Ph.D./CE	Assistant Professor	Full Time	Structural Engineering
Cecila	Wright Brown	Lecturer	D.Eng./CE	Associate Professor	Full Time	Construction Management

I.2. Pedagogy Training for Faculty

I.2.1 Pedagogy that meets the needs of the students

At the beginning of every academic year, Morgan offers 3-day Faculty Institute, School/College, and department meetings. The keynote presentation, guest presentations are always pedagogy and learning management system-oriented, which helps our faculty share ideas and develop skills to improve their approach to this topic in our classroom.

Additionally, the Morgan Foundation financially supports faculty members' attendance with presentations at local and/or national "professional/technical" conferences.

During the academic year, the University and the School of Engineering organize faculty development workshops, seminars, lectures on all kinds of pedagogy topics/issues.

I.2.2. Canvas – learning management system

We use the Canvas learning management system. Canvas streamlines all the digital tools and content that teachers and students love, for a simpler and more connected learning experience.

I.2.3.Evidenced-based best practices for distance education

This is not applicable to this program.

J. Adequacy of Library Resources

J.1. Library Resources

J.1.1. Morgan Library

The students will have access to Morgan State University Earl S. Richardson Library (Morgan Library). The Morgan Library offers a range of resources and services to the Morgan community. Most library resources (USMAI Catalog, WorldCat MORGAN, Libguides, Collections, etc.) and services can be accessed remotely.

J.1.2. Required Library Resources

The Ph.D. program requires modest additional library resources - books and journals on Computational Engineering Mechanics, Construction Engineering and Management, Environmental Engineering and Water Resources, Structural Engineering, Geotechnical Engineering, Transportation Engineering, etc.

J.1.3. Bookstore

Morgan State University's bookstore will sell Sustainable and Resilient Infrastructure Engineering textbooks, lab materials, and software, as required for the appropriate courses.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Equipment

K.1. Assurance of Physical Facilities, Infrastructure, and Instruction Equipment

K.1.1. Physical Facilities

The Ph.D program in Sustainable and Resilient Infrastructure Engineering is administered by the Department of Civil Engineering, out of the Center for the Built Environment and Infrastructure Studies (CBEIS) Room 101, and housed in existing laboratories located throughout SEB. The Ph.D. program will benefit immensely from the vast laboratory resources available in the Department of Civil Engineering, which currently includes

several instructional and research laboratories, as well as computer laboratories. Based on the current inventory of resources, there is no anticipated critical shortage of teaching and research resources at the initial stages of the development of the new Ph.D. program. Funds generated from research grants will support the maintenance and upgrade of the civil engineering laboratory.

1. CE GEOTECHNICAL RESEARCH LABORATORY

This lab focuses on experimental investigation of soil property on mechanical behavior of soil, such as deformation and failure under different types of loads. Various factors are considered in design of various experimental investigations for various types of soils, such as frozen and defrost soils, soils physically reinforced with geofiber, soils chemically stabilized with fly ash or lime, etc. Various tests with different testing conditions can be conducted, such as saturation and consolidation tests, dynamic and static loading test, resilient modulus tests, resonant column tests, etc. Dynamic loading systems can simulate various types of forces inducted by traffic loads, wind blow, sea waves, earthquakes, foundation vibration, etc. Static loading systems can be applied to various experiments with either stress or strain control to investigate stress-strain relation, soil failure, elastic modulus, and other soil properties. This lab has six new testing systems, including a solid consolidation device, a static triaxial apparatus, two dynamic triaxial testing systems, a soil resonant column, and a triaxial-torsional shear system.

2. CE STRUCTURES AREA LABORATORIES

The CE Materials and Structures Laboratories are for both teaching and research. Equipment in these labs support concrete and asphalt tests, universal tension and compression and torsion testing, fatigue and creep measurements, pendulum impact testing, hardness tests, structural mechanics experiments as well as load frame measurements of structural response. The CE Structures Research laboratory, which includes a 6DOF seismic simulator (CBEIS 121) and strong-floor, strong-wall facility, supports research and contracts in seismic testing and simulation, structural dynamics and control, materials characterization and behavior, and advanced macro- and micromechanics; with advanced displacement (including 3D non contact) measurement tools, sensors and actuators of various types, and data acquisition and control systems. The structures area laboratories are also supported by a Student Projects Lab with welding, cutting, drilling, and various tools for fabrication of small and large articles, including a five-axis machining center.

3. CE ENVIRONMENTAL RESEARCH LABORATORIES

Environmental research in the Department of Civil Engineering focuses on the identification of chemical pollutants in water and wastewater, development of innovative physical, chemical and biological treatment processes, along with the necessary management and decision support strategies for establishing green infrastructure to mitigate impacts that threaten our water resources. Our academic and research programs also build upon Morgan's strong interdisciplinary focus on studying the resilience of existing and future water infrastructure, and protection of the ecological services yielded by the Chesapeake Bay Watershed. The environmental labs in CBEIS feature analytical equipment available in two environmental research laboratories, including the latest equipment available from PerkinElmer:

4. CENTER FOR ADVANCED TRANSPORTATION AND INFRASTRUCTURE ENGINEERING RESEARCH (CATIER)

CATIER seeks solutions to complex engineering problems primarily dealing with optimization in the areas of transportation and infrastructure engineering, with a recent focus on interactions among transportation, energy, and environment. Over the last 10 years, the center has conducted research related to highway design, infrastructure maintenance, traffic engineering, asset management systems, and transportation security.

5. CE FLUID MECHANICS RESEARCH LABORATORY

Morgan State University is embarking on cutting-edge research in the areas of heavy lift, fracture mechanics, plasma aerodynamics and supercavitation. As such, Morgan is fortunate to have approval for additional assets, such as subsonic and supersonic wind tunnels, with access to hypersonic wind tunnels located at the Department of Defense White Oak, Maryland Facility. Moreover, Morgan is a user of NASFRO, ANSYS, FLUENT, CFX and NASA OVERFLOW2. Finally, Morgan has experience with NASTRAN.

6. CE GEOSPATIAL TECHNOLOGY LABORATORIES

This lab is for undergraduate research and training in geospatial sciences and technologies. Research focuses on data acquisition, analysis, and synthesis in both STEM and non-STEM disciplines. It is equipped with 20 high-resolution double-monitor workstations, GTICO ACCUTAB digitizer, wide-format scanner, Trimble Handheld DGPS, a suite of remote sensing and GIS software, and several remotely sensed datasets including Landsat MSS/TM, SPOT, and IKONOS satellites images. This lab is used for training of graduate students in the geospatial technologies and sciences. Students focus on utilizing remote sensing, geographic information system (GIS), and global positioning system (GPS)/differential GPS in their research. It is equipped with 10 high-resolution double-monitor workstations, Leica TotalStation for surveying, a 6-panel VisWall state-of-the-art visualization capability, a spectroradiometer for hyperspectral remote sensing, and a suite of GST software including ArcGIS and ENVI. Remotely sensed datasets include both multispectral and hypersdpectral satellite images. CE Faculty Geospatial Research Laboratory is dedicated to faculty and collaborators involved in joint research projects utilizing GST. It is equipped with 6 high-resolution double-monitor workstations, an high-resolution HP wide-format plotter, an 18-panel VisWall state-of-the-art visualization capability, an ASD FieldSpect 4 Spectroradiometer for hyperspectral remote sensing, Trimble GoeExplorer 6000 DGPS, and a suite of GST software including ArcGIS and ENVI. Remotely sensed datasets include both multispectral and hypersdpectral satellite images.

Table 6. Equipment available in the Civil Engineering Laboratories

MORGAN STATE UNIVERSITY INVENTORY LIST OF EQUIPMENT IN CBEIS AT-A-GLANCE	**Geotechnical**	**Structural**	**Environmental**	**Fluid Mechanics**	**Geospatial**	**In Progress**
GDS Resonant Column Testing System	√					
GDS Small-Strain Hollow Cylinder Testing System	√					
GCTS Cyclic Hydraulic Soil Triaxial System	√					
Geocomp Cyclic Triaxial & Resilient Modulus Testing System	√					
Geocomp Triaxial Compression Testing System	√					
Geocomp Rowe Consolidation Testing System	√					
GIS Workstations	√				√	
Conductivity Measurement Device	√					
Direct/Residual Shear Apparatus	√					
RO-Tap Sieve Shakers	√					
Hydrometer Analysis Test (particle gradation through rate of sedimentation)	√					
Constant/Falling Head Apparatus (coefficient of permeability)	√					
Compaction/Proctor Test (moisture-unit weight relationships)	√					
Magnus Test Frame		√				
Axial Torsion Test Machine		√				
Biaxial Seismic Simulator (shaking table)		√				
Universal Testing Machine (includes ASTM testing protocols)		√				
Pendulum Impact Tester		√				
Hardness Tester						√
Curing Cabinet/Freeze thaw/Gyrator Compactor						√

Concrete Mixer & Slump Test Apparatus						√
Asphalt Oven						√
Air Meter Apparatus (ASTM C231)						√
Concrete Saw/Cylinder Molds/Beam Molds						√
Atomic Absorption (AA) Spectro-photometer with Graphite Furnace			√			
Karl Fischer Triation Unit			√			
Spectroflurometer			√			
Agilent 1100 HPLC			√			
Chiller, 6000 Series			√			
Combiflash Separation System			√			
Vent Hood/Fume Hood			√			
Thermo Spec Gen 10 Spectro			√			
Agilent 7500 ICP-MS			√			
DO/BOD Meter			√			
Vortex Apparatus (Free and Forced Vortex)				√		
Model Sedimentation Tank				√		
Advanced Hydrology Apparatus				√		
Tilting Flume/Reciprocal sediment loop				√		
GTICO ACCUTAB High-resolution Digitizer					√	
Trimble GeoXH Differential Global Positioning System (DGPS)					√	
ASD FieldSpec Spectroradiomenters					√	
18-panel High-resolution VisWall					√	
Leica TS02 TotalStation					√	

Table 7. Software available in the Department of Civil Engineering

SOFTWARE CAPABILITIES (in alphabetical order)	Drafting	Geometrical Modeling	Meshing	Smart Material	Finite Element	Manufacturing	Static Analysis	Nonlinear Time	Computational Fluid Dynamics	Hydro/Aero Dynamic Analysis	Buckling Analysis	Modal Analysis	Fatigue Analysis	Design	Optimization	Mathematical Modeling	Structural Mechanics	Plasma	Fracture	Satellite Orbital Mechanics
ANSYS		√	√	√	√		√	√	√		√	√	√		√		√	√	√	
AQWA			√							√										
ArcView																				
AutoCAD	√	√																		
COMSOL		√	√	√	√		√	√	√		√	√	√				√			
Experience CREO			√		√	√			√								√			
FEMAP	√		√		√				√								√			
FLOWGROW																			√	
Maple																√				
Matlab																√				
NASGROW																			√	
Origin Lab																√				
Pointwise	√		√		√				√								√			
SAP2000		√	√		√		√	√				√		√						
SPK																				√
Staad		√	√		√		√	√				√		√						

K.1.2. Infrastructure Equipment

The Program will also leverage research infrastructure and equipment provided by in the Center for the Built Environment and Infrastructure Studies (CBEIS).

K.1.3. Instruction Equipment

Morgan has comparable research facilities to the other higher education institutions in the State of Maryland. SoE facilities include many laboratories that conduct research in the major concentrations of Civil Engineering.

K.1.4. Required Computer Resources

The proposed Ph.D. in Sustainable and Resilient Infrastructure Engineering requires specialized computer hardware such as desktops, tablets, and other input devices and computer-software resources.

K.2. Program Assurance in Distance Education

Morgan uses Google's Gmail for its email system and Canvas[*] is the learning management system. The Ph.D. in Sustainable and Resilient Infrastructure Engineering will use both traditional classroom and/or a Canvas for online course distribution. Online instruction is supported by video conferencing software Zoom and Google Meet. The School of Engineering classrooms are equipped to support hybrid instruction for simultaneous face-to-face and remote instruction.

[*]https://morganstate.instructure.com

L. Adequacy of Financial Resources with Documentation

L.1. Resources and Narrative Rationale

Resources: The program is primarily resourced by the revenue generated from tuition. No university-level reallocated funds will be required to launch this program. Revenue from tuition/fee is based on the rate established for the School of Graduate at an annual rate of $9,657 and $537 per credit for the 2021-2022 Academic School Year. No grants, contracts, and external sources have been designated for this program.

Table L1. Resources

Resource Categories	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c+g below)	148,074	198,934	239,053	281,399	326,071
a. Number of F/T Students	12	14	16	18	20
b. Annual Tuition/Fee Rate	9,657	9,947	10,245	10,552	10,869
c. Total F/T Revenue (a x b)	115,884	139,254	163,922	189,944	217,381
d. Number of P/T Students	5	9	11	13	15
e. Credit Hr. Rate	537	553	569	586	604
f. Annual Credit Hrs.	12	12	12	12	12
g. Total P/T Revenue (d x e x f)	32,190	59,680	75,131	91,455	108,690
3. Grants, Contracts, and Other External Sources	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (Add 1 – 4)	148,074	198,934	239,053	281,399	326,071

Tuition/Fees Revenue $1,123,582

The graduate tuition and fees for both full time and part time PhD students includes a 3% increase every year for five years.
F/T tuition are calculated with # students X cost per credit X 18 credits annually.
P/T tuition are calculated with # students X cost per credit X 6 credits annually (avg. annual credits)

L.2. Program Expenditures and Narrative Rationale

Table L2. Expenditures*

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	127,800	131,634	135,583	139,651	143,840
a. # FTE	1	1	1	1	1
b. Total Salary	90,000	92,700	95,481	98,345	101,296
c. Total Benefits	37,800	38,934	40,102	41,305	42,544
2. Admin. Staff (b + c below)	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
3. Support Staff (b + c below)	0	49,700	51,191	52,727	54,309
a. # FTE	0	1	1	1	1
b. Total Salary	0	35,000	36,050	37,132	38,245
c. Total Benefits	0	14,700	15,141	15,595	16,063
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 +	0	0	0	0	0
TOTAL (Add 1 – 7)	**127,800**	**181,334**	**186,774**	**192,377**	**198,149**

The total of faculty salary in five years will be $678,508. The FTE faculty will provide instruction and research guidance for existing and future students. The expected salary is approximately $90,000 with a fringe benefit rate of 42% of the base salary. This also includes an annual cost of living allowance (COLA) rate of 3.0%.

Table L3. Faculty 5-Year Salary Projection

Year 1	Year 2	Year 3	Year 4	Year 5
$127,800	$131,634	$135,583	$139,651	$143,840

The total of support staff salary in five years will be projected as $207,926.

Contractual support staff members will assist with the activities and provide programmatic support related to the proposed new program. This position may support coverage of laboratories, IT support, and other areas essential for program success. This support would commence in year 2 thru 5. A contractual fringe of 9.0% and COLA of 3.0% has been applied to the salary.

Table L4. Support Staff 5-Year Salary Projection

Year 1	Year 2	Year 3	Year 4	Year 5
$0	$49,700	$51,191	$52,727	$54,309

M. Adequacy of Provisions for Program Evaluation

Although there are no accreditation bodies like ABET which is used for undergraduate curriculum assessment, Morgan's SoE and Department of Civil Engineering have evaluation procedures for administrators (Dean, Department Chair), faculty, students, Programs, and courses that will be used for this program.

Student performance in courses will be evaluated on the basis of graded assignments, tests, quizzes, attendance, etc. Each semester, students will submit online evaluations of their courses and instructors. Each year, the department chair will evaluate faculty and provide feedback for improvement using faculty annual reports, and the SoE Faculty Evaluation Instrument. The Department Chair will also evaluate faculty with respect to their performance in the Sustainable and Resilient Infrastructure Engineering Ph.D. Program. Subsequently, the dean will evaluate the department chair, and the provost will evaluate the dean, and so on.

Evaluations at each stage are based on specific and well-defined procedures and criteria that are made known in advance, including syllabi, questionnaires, reports, job descriptions, and evaluation forms. Collecting, managing, and reporting data are time-consuming and very important processes.

The purpose of the evaluations are to: 1) build a stronger school, departments, programs, and courses; 2) track and help improve the performance of administrators, faculty, and students; 3) enhance the rigor of teaching and learning; and 4) promote more effective services.

In case of an overall unsatisfactory evaluation, a Performance Improvement Plan must be developed the next semester or academic year and be approved by the CE Department Chair and Graduate Coordinator.

M.1. Procedures for Evaluating Courses, Faculty and Student Learning Out- comes

At the end of each semester, the CE Department Chair will evaluate each course, course instructor (peer evaluation), and student performance; meet with the course instructor to go over the evaluation results and to make suggestions for goals and objectives for the new semester. At the end of each academic year, the Department Chair will also evaluate Program performance and meet with the Department Graduate Coordinator to go over the evaluation results and make suggestions and recommendations for program adjustments for the next academic year.

M.1.1. Criteria for Course Evaluation

· Course Organization

– Are the following policies clearly stated in the syllabus?

∗ Course objectives

∗ Requirements

        - Grading
        - Attendance
    - Is the content taught suited to the stated course objectives?
    - Does the instructor use technology appropriately?
    - Is class time used productively?
    - Does the course use active learning pedagogy?
    - Does the course cater to a variety of learning styles?
- Assignments
    - Are the following appropriate for this course?
        - Homework
        - Technical Writing
        - Projects
        - Tests
        - Textbooks and other assigned reading
    - Do assignments effectively promote positive student learning outcomes?
- Grading
    - Does the instructor provide useful feedback on assignments?
    - Do examinations reflect important aspects of the course?
    - Is the grading system fair and clearly explained at the beginning of the semester?
    - Are assignments graded properly and promptly?
- Communication
    - Does the instructor explain complex ideas well?
    - Does the instructor show and inspire enthusiasm for the subject?
    - Does the instructor answer students' questions clearly?
    - Does the instructor use examples and illustrations to clarify material?
- Interaction with students
    - Does the instructor treat all students respectfully, fairly, and without bias?
    - Does the instructor respond to student communications promptly?
    - Does the instructor encourage student participation in the classroom?
    - Is the instructor open to different points of view?
    - Is the instructor available to provide individual help to students?
    - Does the instructor seem genuinely concerned with students' progress in the course?

M.1.2. Criteria for Program Evaluation

The main criteria for Program evaluation are:

- student enrollment
- graduation rate
- student retention
- cost-effectiveness
- assessments of student learning outcomes
- student placement in internships and employment

M.1.3. Criteria for Faculty Evaluation

Faculty must satisfy the following criteria:

- Prepare quality syllabus, tests, quizzes, and assignments
- Demonstrate mastery of subject matter and classroom management
- Timely graded material return
- Effective use of university-approved learning management system (e.g., Canvas), pedagogy and student advisement and teaching tools (e.g., Starfish, Degree Works)
- Hold regular office hours

These are the same criteria used for promotion and tenure. Failure to meet any one of these criteria will automatically result in an unsatisfactory teaching rating.

M.1.4. Criteria for Student Learning Outcomes Evaluation

The course instructor will tailor assignments to assess students' aptitude against the objectives of the course and the desired student learning outcomes.

After completing the Ph.D. in Sustainable and Resilient Infrastructure Engineering degree, students will have the knowledge and skills needed to successfully:

- Use design standards, research methodologies, and analytical techniques to solve real-world infrastructure problems and grand challenges in the urban built environment.
- Understand and follow trends in urban infrastructure engineering, resiliency, and sustainability.
- Function effectively in teaming environments to accomplish a common goal
- Exhibit professional, ethical, legal, security, and social issues and responsibilities
- Communicate effectively both in writing and orally.

N. Consistency with the State's Minority Student Achievement Goals

N.1. Minority student Access & Success, and Morgan's Cultural Diversity Goals and Initiatives

The Ph.D. in Sustainable and Resilient Infrastructure Engineering Program is designed to recruit, retain graduate and place students, especially minority students, in meaningful employment in one of the largest and fastest-growing technology sectors in the United States and the world. These goals are consistent with Morgan State University's goals and initiatives to promote minority student access and success and to recruit diverse, high-quality faculty.

O. Relationship to Low Productivity Programs Identified by the Commission

O.1. Relationship to Low Productivity Program

There is no relationship to any low-productivity programs identified by the Commission.

P. Adequacy of Distance Education Programs

P.1. Affirmation of Distance Education Eligibility

The Maryland Higher Education Commission (MHEC) has approved Morgan to offer ten (10) online degree and five (5) online post-baccalaureate certificate programs. As of academic year, 2018-2019 two hundred and forty-seven (247) faculty members have been trained through Quality Matters to develop and teach online courses and more than sixty-two hundred (6,200) students have enrolled in the University's online courses.

The Office of Morgan Online was established in 2013 and a full-time Director was hired in 2014 as a function of the President's reorganization of his administration to better realize the 2011 – 2021 Strategic Plan goals. Morgan is a member institution of Maryland Online, a consortium of community colleges and senior institutions in the state of Maryland dedicated to championing distance education and enhancing the quality and availability of e-learning in Maryland and worldwide. The Director of Morgan Online is a Vice President of Maryland Online.

In summary, Morgan is fully invested in supporting its online degree and certificate programs. Its faculty are appropriate trained through Quality Matters to develop and teach online courses. The University's Board of Regents has approved a Policy for Online and Hybrid Courses that is published in the Faculty Handbook in order to establish criteria and guidelines for the development and delivery of high quality online and hybrid courses and online programs.

The Program will be agile in its offering to support both face-to-face and online instruction delivery. Most of the instructional courses, if not all, can be offered online including those that are more project based. However, dissertation research projects requiring specialized instrumentation can be done in a remote laboratory environment. Lastly, the ability for students to obtain certifications is also an anticipated outcome of this Program.

P.2. Institutional Compliance with the C-RAC Guidelines

Morgan compiles with the Council of Regional Accrediting Commissions (C-RAC) guidelines - Inter-regional Guidelines for the Evaluation of Distance Education. However, C-RAC Guidelines are not related to the proposed Ph.D. in Sustainable and Resilient Infrastructure Engineering because it's not a distance learning program.

Appendix I. Morgan State University

Morgan is Maryland's Preeminent Public Urban Research University, and the only university designated a National Treasure. Founded in 1867, the Baltimore-based HBCU is celebrating its 152nd of excellence in higher education.

For 152 years, Morgan has been an essential part of the higher education system in Baltimore City, the State of Maryland, and the United States of America. Throughout its history, Morgan has served the community with distinction while meeting the educational needs of an increasingly diverse society. Morgan is one of the few historically black institutions nationally to offer a comprehensive range of academic programs from computer science, mathematics, and natural sciences to engineering, business, and education.

Morgan has also recently been elevated from a Carnegie Doctoral Research University (R3) classification to an High Research Activity University (R2).

Morgan has the Middle States Association of Colleges and Schools, Commission on Higher Education Accreditation from 01/01/1925. Morgan is comprised of one college and nine schools:

- James H. Gilliam's College of Liberal Arts
- School of Architecture and Planning
- Earl G. Graves School of Business and Management
- School of Community Health and Policy
- School of Computer, Mathematical, and Natural Sciences
- School of Education and Urban Studies
- Clarence M. Mitchell School of Engineering
- School of Global Communication
- School of Graduate Studies
- School of Social Work

Morgan has the academic programs at both undergraduate and graduate levels:

- 69 bachelor's degree Programs (including the 4 BS to MS programs)
- 6 post-baccalaureate's certificates
- 39 master's degree Programs
- 18 doctoral degree Programs

Morgan has several distinguished faculty in the School of Computer, Mathematical and Natural Sciences, the School of Engineering, and the School of Business and Management who have the background and expertise to deliver the BS in Cloud Computing Program and courses.

Morgan enrolls 7,800 students in programs ranging from baccalaureate to doctoral degrees. Morgan attracts students from each state and many foreign countries. Approximately 35% of all students enrolled at Morgan are from outside the state of Maryland. Most matriculating students are from Maryland, New York, New Jersey, and Pennsylvania. Nationally, Morgan is one of the leading institutions for receiving admission applications from African American high school graduates.

Morgan awards more bachelor's degrees to African American students than any other college or university in the state of Maryland. Morgan accounts for large percentages of degrees received by African Americans from Maryland universities and colleges. Morgan has ranked among the top public universities and colleges nationally in the number of minority graduates receiving doctorates.

While Morgan is an HBCU, it has served students of all racial and ethnic backgrounds. Its mission today is to enroll a student body that is diverse in its socioeconomic and academic status and to provide the full range of experiences and services that permit it to serve students with a wide variety of goals and needs.

Appendix II. School of Engineering

The School of Engineering consists of four departments namely:

- Department of Civil Engineering
- Department of Electrical and Computer Engineering
- Department of Industrial and Systems Engineering
- Department of Transportation and Urban Infrastructure Studies

The School of Engineering offers Bachelor's degree Programs, a Master's of Engineering Program, a Doctorate of Engineering Program, and post-baccalaureate certificate programs. A complete list of all degree offerings is given below:

- Bachelor of Science in Civil Engineering
- Bachelor of Science in Electrical Engineering
- Bachelor of Science in Industrial Engineering
- Bachelor of Science in Mechatronics Engineering
- Bachelor of Science in Transportation Systems
- Bachelor of Science in Transportation Systems Engineering
- Bachelor of Science in Mechatronics
- Bachelor of Science in Civil Engineering to Master in Engineering (BS to MEng)
- Bachelor of Science in Electrical Engineering to Master in Engineering (BS to MEng)
- Bachelor of Science in Industrial Engineering to Master in Engineering (BS to MEng)
- Bachelor of Science in Electrical Engineering to Master in Science (BS to MS)
- Post-Baccalaureate Certificates in Cybersecurity and Transportation
- Masters of Engineering (All Departments)
- Doctor of Engineering (All Departments)
- Ph.D. in Secure Embedded Systems
- Ph.D. in Transportation

Appendix III. Department of Civil Engineering

The Program of Civil Engineering (CE) was established in 1984 with a simple goal of converting any hard-working student from a high school into a high caliber engineering professional. It currently is the sixth largest program among 125 academic programs at Morgan State University. The CE undergraduate program has been the 1st provider of African American civil engineers in both Maryland and the United States. It is accredited by the Engineering Accreditation Commission of ABET (Accreditation Board for Engineering & Technology). Our undergraduate students build a broad foundation in all aspects of civil engineering through the CE program. Concentrations are offered in the areas of geotechnical engineering, environmental engineering, transportation engineering, structural engineering, hydraulics and hydrology, construction engineering and management, and earthquake engineering. The solid and broad foundation provides our graduates with confidence to apply and accept employment from federal, state, and local agencies as well as private engineering firms.

Collaboration of the CE department with other universities offers our students several options to broaden their education. Graduate students can earn dual doctoral degrees from Carnegie Mellon. Undergraduate students can earn a dual degree with Purdue University. Our collaboration with local community colleges allow students to start their engineering coursework at the community college level and complete the bachelors here at Morgan.

CE faculty members are highly qualified by virtue of their education, professional licensure, and industry experience. They offer course work rooted in current industry practice and trends. They offer the students opportunity to participate in cutting edge research projects which support MSU rating as a doctoral research institution with Carnegie Classification R2 (High Research Activity). The research is supported by sixteen modern laboratory facilities with state-of-the-art research grade laboratory equipment. This includes major equipment such as a seismic simulator, drop tower, supersonic wind tunnel, vibration table, scanning vibrometer, cyclic triaxial equipment, resilient modulus testing equipment, large water flume, and several specialized software packages. The labs and dedicated laboratory staff are made available to all students interested in research or experiments that complement their capstone projects.

MSU is the largest HBCU in Maryland. Despite the label, the faculty, staff and student bodies in the CE program are highly diversified and represent many cultures from all over the world. The CE Department has a significant percentage of international students (about 27% in 2019). The rest of our students come from all walks of life and represent several states. The CE department encourages and supports participation in active student organizations such as American Society of Civil Engineers (ASCE), American Concrete Institute (ACI) and Chi-Epsilon (The Civil Engineering Honor Society) with the goal of increasing our students' exposure to the diversity in the civil engineering field. Student participation in these organizations is also strongly encouraged because it allows our students to interact with their peers through friendly regional and national competitions.

The CE Department has 13 faculty members: 1 tenured full professor, 1 tenured associate professor, 6 tenure-track assistant professors, 1 professor of practice, and 4 full/part-time lecturers.

- Full Professors
  - Jiang Li, Ph.D., PE (jiang.li@morgan.edu)
- Associate Professors
  - James Hunter, Ph.D. (james.hunter@morgan.edu)
- Assistant Professors
  - Steve Efe, D.Eng. (steve.efe@morgan.edu)
  - Dong Hee Kang, Ph.D., PE. (donghee.kang@morgan.edu)
  - Oludare Owolabi, Ph.D., P.E. (oludare.owolabi@morgan.edu)
  - Yi Liu, D. Eng, P.G. (yi.liu@morgan.edu)
  - Mehdi Shokouhian, Ph.D. (mehdi.shokouhian@morgan.edu)
- Professor of Practice
  - Gbekeloluwa Oguntimein, Ph.D., PE (gbeke.oguntimein@morgan.edu)

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- Full/Part-Time Lecturers
  - Emad Gheibi, Ph.D., P.E.
  - A. Simon Oladele, Ph.D., P.E.. (adewolesimon.oladele@morgan.edu)
  - Cecelia Wright Brown, D.Eng. (Cecelia.wrightbrown@morgan.edu)
  - Kiruthia Saminathan, MS (Kiruthia.Saminathan@morgan.edu)Appendix IV. Morgan State University Vision and Mission

Appendix IV. Morgan State University Mission

Vision Statement

Morgan State University is the premier public urban research university in Maryland, known for excellence in teaching, intensive research, effective public service and community engagement. Morgan prepares diverse and competitive graduates for success in a global, interdependent society.

Mission Statement

Morgan State University serves the community, region, state, nation, and world as an intellectual and creative resource by supporting, empowering and preparing high quality, diverse graduates to lead the world. The University offers innovative, inclusive, and distinctive educational experiences to a broad cross-section of the population in a comprehensive range of disciplines at the baccalaureate, master's, doctoral, and professional degree levels. Through collaborative pursuits, scholarly research, creative endeavors, and dedicated public service, the University gives significant priority to addressing societal problems, particularly those prevalent in urban communities.

Appendix V. Morgan State University Strategic Goals

Leading the Future

The University's emerging 2021–2030 strategic goals are notably consistent with its previously articulated 2010–2021 goals. In essence, it was determined that those previously stated goals were interconnected and worthy of sustainable emphases. The 2021-2030 Strategic Plan reaffirms and reformulate six interdependent strategic goals that focus on the emerging growth opportunities over the next ten years. These goals will guide Programs, services, and budgets that are designed to lead Morgan's future by implementing the strategic initiatives for each goal. The goals include:

Goal 1: Enhancing Student Success and Well-Being

Morgan strives to create an educational environment that enhances student success by offering new academic programs and holistic co-curricular activities in a welcoming, diverse and inclusive campus community. The goal here is to provide students with a comprehensive educational and transformative experience that actualizes their full potential and empowers them to emerge as confident and competent global citizens and dynamic leaders in their selected careers and communities. This broadly stated goal encompasses student enrollment and retention functions. Thus, primary and cross-sectional responsibility for all of these functional areas is jointly shared by the Provost & Senior Vice President, the Vice President for Enrollment Management and Student Success (EMASS) and the Vice President for Student Affairs.

Goal 2: Implement Faculty Ascendency and Staff Development Initiatives

The University will implement a broad range of human resource development initiatives for the benefit of faculty and staff. These initiatives will facilitate the ascendency of faculty to higher ranks and provide staff with progressive opportunities for professional development and merit-based promotions. Without question, a sharp focus on effective human resource planning will have a direct and determinative bearing on the execution of our overall strategic plan. Over the next ten years, the University will need to attract, retain, and promote junior and senior faculty. Also, staff will require opportunities to retool and acquire specialized skills leading to professional growth and enhanced opportunities for promotion and progressive compensation.

Goal 3: Elevate Morgan's Status to R1 Very High Doctoral Research University

Over the next ten years, Morgan will emerge as a R1 doctoral research university fully engaged in basic and applied research and creative interdisciplinary inquiries undergirded and sustained through increased research grants and contracts. The realization of this goal is predicated on a distinctive MSU faculty presence and preeminence in STEM and non-STEM disciplines and the strengthening of an effective educational pipeline advancing students from the baccalaureate to the doctoral level. This is an institution-wide goal to be pursued at the enterprise level. Primary responsibility for achieving this goal rests with the Vice President for Research and Economic Development working in close, inter-office collaboration with the Provost, Deans, Faculty and all members of the President's senior administrative team.

Goal 4: Expand and Improve a Campus-Wide Infrastructure to Support Operational Excellence and Increase Overall Institutional Capacity

Morgan will advance new construction, capital improvement, deferred maintenance, and campus safety projects in keeping with the University's evolving master plan. The University will also implement an

information technology plan to accommodate and optimize operational excellence in all aspects of its service delivery. This expanded and improved infrastructure will accommodate a projected increase in student enrollment (traditional and non-traditional) and a surging demand for on-line learning options. This goal also encompasses a number of recommendations to implement campus-wide safety measures and enhance student well-being.

Goal 5: Serve as the Premier Anchor Institution for Baltimore City and Beyond

Morgan will expand and deepen its role as a recognized anchor institution with broad social and economic impact. The University will engage community residents and officials in the application of knowledge and policy analyses derived from faculty and student research, an appropriate sharing of mutually beneficial resources and the deployment and utilization of University experts and professionals to address local and regional concerns in the areas of public education, housing, safety, employment and neighborhood revitalization. In this way, Morgan State University will serve as a dynamic epicenter dedicated to the generation, integration and dissemination of new knowledge as a driving force to effect policy and catalyze meaningful social change.

Morgan State University faculty and students will be actively involved in this work. Previous activities drew upon the expertise and experience found in outstanding academic units such as the School of Architecture and Planning, the School of Business and Management, the School of Community Health and Policy, the School of Computer, Mathematical and Natural Sciences, the School of Engineering, the School of Global Journalism and Communication, the School of Social Work and the School of Graduate Studies. The School of Education and Urban Studies (SEUS), in particular, will play a pivotal role in generating research that is specific to the needs of urban K-20 learners in the city and state, and in the design and implementation of research-based interventions that are targeted to the needs of local residents.

Goal 6: Accelerate Global Education Initiatives and Expand the University's International Footprint

Morgan will enhance its study abroad program and promote global awareness and intercultural competencies through its diverse curricular and co-curricular programs and activities. The University will also increase international student enrollment and leverage its ongoing presence in West Africa to develop effective and replicable models of excellence in international development and responsive, market-based educational service delivery in Latin America and the Caribbean nations.

Appendix VI. Priorities and Enhanced Goals for 2019-2023

(Goals that bridged from previous 2011-2021 Strategic Plan to the current plan)

Enhancing Student Success and Experiences

Targets: improved student housing, increased retention rate, increased graduation rate (to 50 % by 2025), additional student activities and amenities, and more study abroad opportunities

Improving Morgan's Infrastructure

Targets: capital improvements and additions, opening of a branch campus and addressing deferred maintenance

Enhancing Doctoral Research University Standing

Targets: Carnegie R1 rating, increased contracts and grant amounts, strengthened Computer Science Department, School of Engineering expansion, addition of new research centers and labs, creation of two to five start-up companies and strengthening Tech Transfer operation

Increasing Resources

Targets: increased State of Maryland support, increased alumni giving percentage (from 17 percent to 21 percent) and completion of $250-million Sesquicentennial Anniversary Campaign

Managing Student Enrollment

Targets: the growth of online degrees and online Programs, increased number of international students, enhanced campus diversity, 9,000–10,000 student enrollment count and more in-state and out-of-state students

Expanding Community Engagement and Support

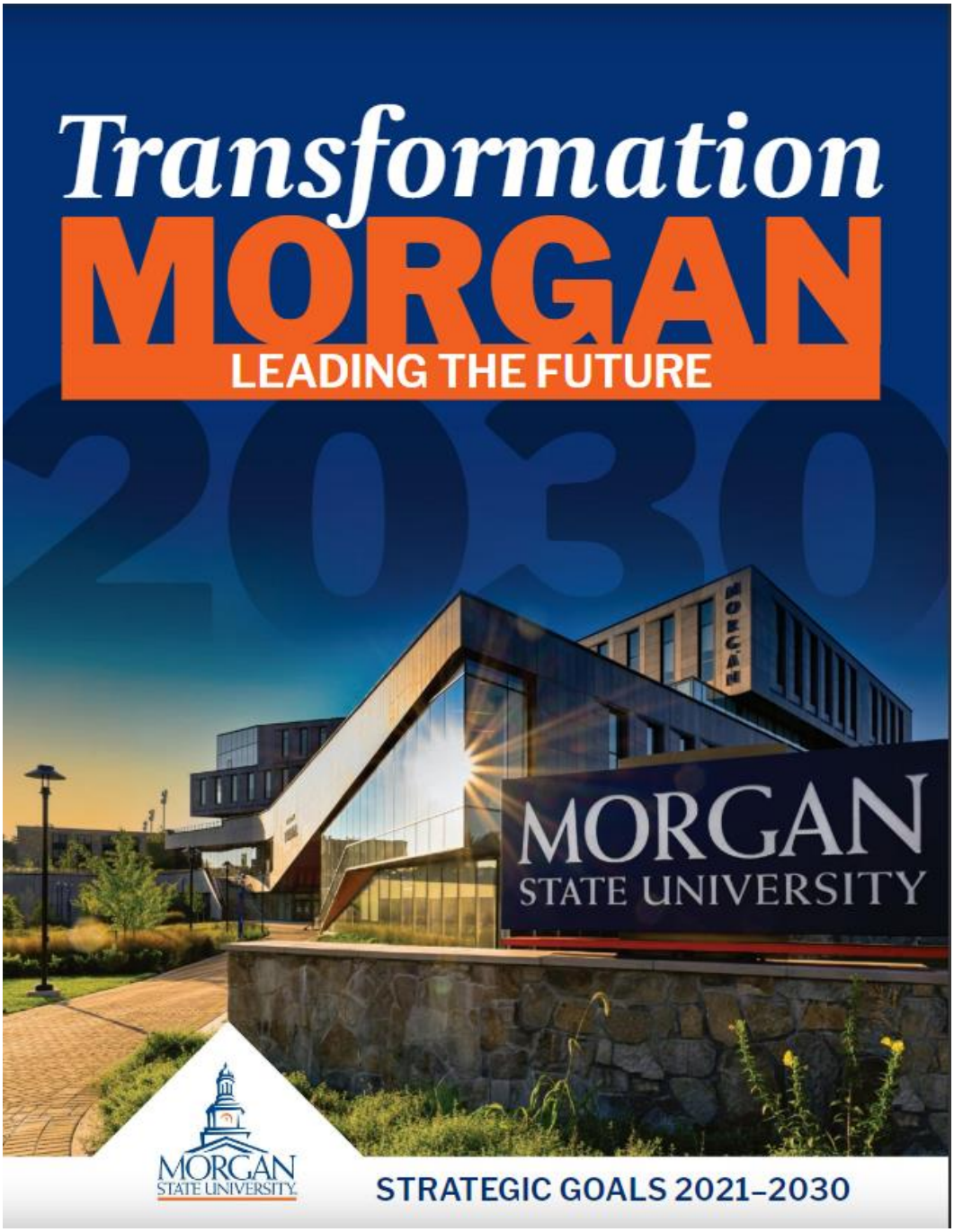
Target: further collaboration along and surrounding the Hillen Road corridor

Advancing Athletics

Targets: Academic Progress Rate improvement in all 13 sports and attainment of MEAC championships

Appendix VII. Transformation Morgan 2030: Leading the Future

Strategic Plan for Morgan State University for 2021–2030



Approved by the Board of Regents on 8/3/21. A complete copy of the document can be found at the link below: https://issuu.com/morganstateu/docs/msu_strategic_plan_2022-2032_final?fr=sNzZjMDI5MDk3ODE