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 Computer and Electrical Systems Engineering with a pass-through (En Passant) Master of Science (M.S.) in Computer and Electrical Systems Engineering"* 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

Office Use Only: PP#

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	Computer and Electrical Systems Engineering	
Total Number of Credits	60	
Suggested Codes	HEGIS: 909.00	CIP: 14.1001
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 Computer and Electrical Systems Engineering with a pass-through (e*n passant*) Master of Science (M.S.) in Computer and Electrical Systems Engineering

Contents

A. Centrality to Institutional Mission and Planning Priorities

A.1. Program Description 4
A.1.1 Program of Study 4
A.2. Strategic Goals Support and Affirmation 5
A.3. Five Year Funding Plan 5
A.4. Morgan Commitment 6

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan 6

B.1. Program Demand and Need 6
B.1.a) The need for the advancement and evolution of knowledge 7
B.1.b) Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education 7
B.1.c) Need to strengthen and expand the capacity of HBCU 7
B.2. Compliance with State Postsecondary Education Plan 7

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State 8

C.1. Computer and Electrical Systems Industry 8
C.2. Employment Opportunities in Electrical and Computer Systems Engineering 9
C.3. Salaries of Embedded Systems Professionals 9
C.4. Current and Projected Supply of Prospective Graduates 12

D. Reasonableness of Program Duplication 13

D.1. Similar Programs 13
D.2. Justification for Proposed Program 13

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs) 13

F. Relevance to the identity of Historically Black Institutions (HBIs) 13

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes 14

G.1. **Overview 14**
G.1.1. Program Establishment 14
G.1.2. Program Oversight 14

G.2. **Educational Objectives and Learning Outcomes 14**
G.2.1. Program Objectives 14
G.2.2. Expected Student Learning Outcomes 14

G.3. **Program Evaluation 14**

G.4. **Course Descriptions & Program Requirements 14**
G.4.1. Admission Requirements 14
G.4.2. General Requirements 14
G.4.3. Program of Study 15

G.4.4. Example Plan of Study 17
G.4.5. Course Descriptions 20
G.5. **General Education Requirements** **30**
G.6. **Specialized Accreditation or Graduate Certification Requirements** **30**
G.7. **Morgan-JHU Memorandum of Understanding** **31**
G.8. **Program Assurances** **32**
G.9. **Advertising, Recruiting, and Admissions Material** **32**
H. Adequacy of Articulation **32**
H.1. **Articulation with Programs at Partner Institutions** **32**
I. Adequacy of Faculty Resources **32**
I.1. **Program Faculty** **33**
I.2. **Pedagogy Training for Faculty** **34**
I.2.a) Pedagogy that meets the needs of the students 34
I.2.b) Canvas – learning management system 34
I.2.c) Evidenced-based best practices for distance education 34
J. Adequacy of Library Resources **34**
J.1. **Library Resources** **34**
J.1.1. Morgan Library 34
J.1.2. Required Library Resources 34
J.1.3. Bookstore 34
K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment **34**
K.1. **Assurance of Physical Facilities, Infrastructure, and Instruction Equipment** **34**
K.1.1. Physical Facilities 34
K.1.2. Infrastructure Equipment 35
K.1.3. Instruction Equipment 35
K.1.4. Associated Research Centers and Laboratories 35
K.1.5. Required Computer Resources 36
K.2. **Program Assurance in Distance Education** **36**
L. Adequacy of Financial Resources with Documentation **36**
L.1. **Resources and Narrative Rationale** **36**
L.2. **Program Expenditures and Narrative Rationale** **37**
M. Adequacy of Provisions for Program Evaluation **38**
M.1. **Procedures for Evaluating Courses, Faculty and Student Learning Outcomes** **38**
M.1.1. Criteria for Course Evaluation 45
M.1.2. Criteria for Program Evaluation 40
M.1.3. Criteria for Faculty Evaluation 40
M.1.4. Criteria for Student Learning Outcomes Evaluation 40
N. Consistency with the State's Minority Student Achievement Goals **40**
N.1. **Minority student Access & Success, and Morgan's Cultural Diversity Goals and Initiatives** **40**

O. Relationship to Low Productivity Programs Identified by the Commission 41
O.1. Relationship to Low Productivity Program 41
P. Adequacy of Distance Education Programs 41
P.1. Affirmation of Distance Education Eligibility 41
P.2. Institutional Compliance with the C-RAC Guidelines 41

Appendix I. Morgan State University 42
Appendix II. School of Engineering 43
Appendix III. Department of Electrical and Computer Engineering 44
Appendix IV. Morgan State University Mission 45
Appendix V. Morgan State University Strategic Goals 46
Appendix VI. Priorities and Enhanced Goals for 2019-2023 47
Appendix VII. Growing the Future, Leading the World: Strategic Plan for Morgan State University for 2011–2021 48

A. Centrality to Institutional Mission and Planning Priorities

Morgan State University (Morgan)[1] proposes a new academic graduate degree program, Doctor of Philosophy in Computer and Electrical Systems Engineering (hereafter the "Ph.D. in Computer and Electrical Systems Engineering" or the "Program") with an *en passant* (pass-through) Master of Science (M.S.) in Computer and Electrical Systems Engineering. The Programs are offered through the Department of Electrical and Computer Engineering (ECE)[2] in the School of Engineering (SOE)[3].

A.1. Program Description

Many of the world's grand engineering challenges can only be addressed through fundamental research that employs the design, analysis, and application of electrical and computer-based systems that spur discovery, invention and innovation. Grand challenges such as advancing the future of work through artificial intelligence and automation, designing intelligent and responsive urban infrastructure, advancing health informatics, securing cyberspace and harnessing the data revolution will require the tight integration of computer, data, network, electrical, and systems engineering. To address this need, Morgan has established the Ph.D. /M.S. in Computer and Electrical Systems Engineering, which emphasizes fundamental knowledge and research of solutions to complex software and electrical hardware application problems. Students engage in the design of integrated hardware and software solutions for computing, communications, cyber security, power and control applications. Furthermore, Morgan State University and its Clarence M. Mitchell, Jr. School of Engineering (SOE) aspires to be the first Historically Black College and University (HBCU), and one of only a few universities nationwide, to address the workforce development needs attributed to the Fourth Industrial Revolution, or Industry 4.0. Industry 4.0 incorporates Big Data and AI Analytics, Cloud Computing, Augmented Reality, Industry Internet of Things, Autonomous Robots, Electronic Systems, Control Electronics and Cybersecurity.

The Ph.D. program in Computer and Electrical Systems Engineering targets highly motivated students who have already obtained a Bachelor's or Master's degree and desire to pursue career opportunities in academia, commercial industry, defense, government laboratories, federal agencies, consulting, military, or research.

A.1.1 Program of Study

The required minimum coursework for the Ph.D. in Engineering is 60 graduate credits beyond the Bachelor's degree and 36 graduate credits beyond the Master's degree. Students pursuing a Ph.D. directly from a bachelor's degree require 24 credits of foundational elective courses and 15 credits of research courses, and the M.S. degree will be granted after the successful completion of 30 credits of study. Students pursuing a Ph.D. beyond a master's degree require 15 credits of foundational elective courses or research courses combined. The remaining 21 credit requirements are the same irrespective of the entry point. Foundational elective courses are a combination of ECE and non-ECE elective courses that are determined to be of key importance in building the necessary rigor and breath through coursework needed to pursue a dissertation topic. Example Foundational elective topical areas may relate to, but are not limited to: Communications, Signal Processing, RF and Millimeter wave Systems, Computer Engineering, Control Systems, Electronic Materials, and Power Systems. Students can also have outside elective courses as approved by the Program Director. Any non-research EEGR graduate course at the 500 – 700 level that is listed in section G.4.5 can serve as a Foundational Elective course. After the student becomes a doctoral candidate, the student can take EEGR 9xx Doctoral Dissertation Research (15 credits). The student will defend the dissertation and receive 3 credits of EEGR 998 Dissertation Defense in the final semester. Up to four courses (not to exceed 12 credits) from other accredited institutions may be accepted for transfer towards the Ph.D. degree, assuming that students do not use transfer courses to satisfy the academic requirements of the former program. Transfer courses at a grade of B or above are approved by the corresponding department.

A typical program for a full-time student to earn this Ph.D. degree will be about 4 years beyond a B.S. degree with a roadmap such as:
First Year: 18 credits of coursework.
Second Year: 18 credits of coursework and/or research coursework.
(After Successful completion of 30 credits the student is awarded the *en Passant* Masters degree.)
Third Year: 15 credits of research coursework.
Fourth Year: 9 credits of dissertation research coursework, including dissertation defense.

[1] Appendix I

[2] Appendix II

[3] Appendix III

A typical program for a full-time student to earn this Ph.D. degree beyond a master's degree will be about 3 years with a roadmap such as:
First Year: 18 credits of coursework and/or research coursework.
Second Year: 15 credits of dissertation research coursework.
Third Year: 3 credits of dissertation defense coursework (998) after successful completion of dissertation research.

Complete details on the requirements for this Ph.D./M.S. program can be found in Section G.4 of this proposal document.

A.2. Strategic Goals Support and Affirmation

Growing the Future, Leading the World: The Strategic Plan for Morgan State University (2011 - 2021) (the Strategic Plan) [4] consists of five broad goals including Enhancing Student Success, Enhancing Morgan's Status as a Doctoral Research University, Improving and Sustaining Morgan's Infrastructure and Operational Processes, Growing Morgan's Resources, and Engaging with the Community. These Strategic Plan goals guide the development and implementation of the University's academic programs, student services, and institutional budgets. The proposed Ph.D. /M.S. in Computer and Electrical Systems Engineering supports three of Morgan's Strategic Plan goals:

Goal 1: Enhancing Student Success

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. /M.S. in Computer and Electrical Systems Engineering enhances Morgan's instructional capacity, attracts underrepresented students, and develops world-leading professional engineers capable of developing solutions that impact regional, national and international communities. This program not only provides more academic offerings for the School of Graduate Studies, including new online course offerings, but also enhances the research capabilities of the School of Engineering to better prepare students to tackle the grand challenges faced by society today.

Goal 2: Enhancing Morgan's Status as a Doctoral Research University

The Ph.D. in Computer and Electrical Systems Engineering will facilitate the growth of the university's research capabilities in support of the recently acquired Carnegie high research activity designation. This will be accomplished through increased production of Ph.D. graduates, scholastic output, and sponsored research.

Goal 3: Growing Morgan's Resources

The Program expands Morgan's human capital and financial resources by investing in the professional development of faculty, staff, and students, establishing collaborative relationships with private and public entities.

A.3. Five Year Funding Plan

Morgan has committed sufficient resources to: 1) recruit 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. Currently, this program is supported by 14 faculty within the Electrical and Computer Engineering (ECE) department. Faculty searches are underway to hire additional faculty with research interests well aligned with the program.

The Department of Electrical and Computer Engineering has faculty with extensive experience in communications and signal processing, computer and software engineering, cyber security, embedded systems, artificial intelligence/machine learning, control systems, and hardware/software assurance.

[4] Appendix V

To prime the pipeline for the Program, a portion of new enrollments in the current Doctor of Engineering program will be considered for admission into the Ph.D. /M.S. in Computer and Electrical Systems Engineering program. If necessary, these students would utilize currently available funding mechanisms, such as financial assistance from the School of Graduate studies and scholarships, to cover Program tuition costs. Additional students will be supported through current and new research funding. Our faculty have established research collaborations and strategic partnerships with the National Science Foundation (NSF), National Institute of Standards and Technology (NIST), the Lockheed Martin Corporation, Northrop Gunman, Aerospace Corporation, National Security Agency (NSA), Howard University, Department of Navy, the University of Maryland at College Park, Sandia Laboratories, the Applied Physics Lab, and the Test Resource and Management Center.

A.4. Morgan Commitment

The proposed Ph.D. /M.S. in Computer and Electrical Systems Engineering 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. For example, Morgan has established the university-wide Center of Assurance and Policy, with an annual $2M state appropriation with a mission to provide the electronics industry and intelligence community with knowledge, methodology, solutions, and highly-skilled professionals to help prevent the penetration and manipulation of our nation's cyber-physical infrastructure.

Morgan will support the Ph.D. /M.S. in Computer and Electrical Systems Engineering with 14 faculty, with a potential for an additional four 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[4] and its planning priorities[5] [6], this proposal for a Ph.D. /M.S. in Computer and Electrical Systems Engineering 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, the first goal of Growing the Future, Leading the World: The Strategic Plan for Morgan State University, 2011-2021. In an effort 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. Morgan State University and its Clarence M. Mitchell, Jr. School of Engineering (SOE) aspires to be the first Historically Black College and University (HBCU), and one of only a few universities nationwide, to address the workforce development needs attributed to the Fourth Industrial Revolution, or Industry 4.0

The demand and need for the Program in terms of present and future needs of the region and the State are detailed in the following subsections.

[4] Appendix IV

[5] Appendix VI

[6] Appendix VII

B.1.a) The need for the advancement and evolution of knowledge

Modern society is faced with many significant problems that impact all aspects of life, from health and security to sustainability and joy of living. Bold visions and innovative approaches that push forward the frontiers of engineering are needed to address these problems. Some of the most critical engineering challenges, such as engineering the tools of scientific discovery, restoring and improving urban infrastructure, and advancing health informatics require the synergy of computer engineering and electrical systems engineering. This program seeks to prepare graduates for careers that bridge electrical engineering and computer science to discover fundamental knowledge and design technical solutions to a wide variety of multi-disciplinary problems and has the potential to alter the course of modern society. Graduates will be motivated to assume responsibility to serve society and behave ethically and make a continuing effort toward the advancement of knowledge and achievement in research and other scholarly activities.

B.1.b) 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.

According to the Survey of Earned Doctorates (SED), universities in the United States conferred 54,641 doctorate degrees in 2017. Of these, 2,963, or 5.4% were awarded to Black students. Furthermore, Blacks only represent 1.7% of all doctorates awarded in engineering disciplines. Many of the federal agencies and labs that address the engineering grand challenges hire a significant number of PhD-trained scientists and engineers. The State of Maryland is home to more than 60 federal agencies and twice as many federal laboratories and features a diversified economy with the fourth-highest concentration of professional and technical workers among the states in the U.S.

B.1.c) Need to strengthen and expand the capacity of HBCU

As stated in the previous section, Maryland is home to a significant number of federal agencies and labs. These labs employ a substantial number of PhDs. Furthermore, the State of Maryland is the epicenter of the intelligence and defense community with a diverse population, and burgeoning tech industry. African Americans make up 30.8% of Maryland's population, in contrast with 13.4% of the United States' population. The Ph.D. /M.S. in Computer and Electrical Systems Engineering in combination with the proximity to these agencies and labs makes Morgan well-positioned to support this community and by extension, the State of Maryland.

B.2. Compliance with State Postsecondary Education Plan

The Ph.D. /M.S. in Computer and Electrical Systems 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.

  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. /M.S. in Computer and Electrical Systems 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 unique, high demand STEM-based program. As African Americans and other minorities continue to be underrepresented in STEM disciplines, offering the Ph.D. /M.S. in Computer and Electrical Systems Engineering at Morgan, one of the State's HBIs, serves to improve access for students underrepresented in this discipline and career pathway.

- **Success**

  The Ph.D. /M.S. in Computer and Electrical Systems Engineering degree 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. With the designation as Maryland's Preeminent Public Urban Research University, there are a unique set of challenges that this program can address and will address that center on social justice issues that plague our communities in urban settings.

- **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. /M.S. in Computer and Electrical Systems Engineering enhances Morgan's tradition of providing unique, high-demand, and innovative academic programs.

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

C.1. Computer and Electrical Systems Engineering Industry

The Computer and Electrical Systems (CES) Engineering industry integrates several fields of computer science and electrical engineering required to develop computer hardware, software and related electrical systems. Engineers within this industry are trained in software and hardware design as well as electrical engineering devices, circuits and systems. CES engineers are involved in many hardware and software aspects of computing, from the design of individual microcontrollers, microprocessors, general computers, to circuit design. Electrical Engineering is grounded in the theories and principles of electromagnetics, electronics, electricity, mathematics, science, and systems engineering.

The disciplines encompassed by CES Engineering, specifically computer engineering, software engineering, and electrical engineering, are some of the most in-demand professionals in the United States and around the world. The work in these industries ranges from renewable energy to microwave and RF engineering, and telecommunications. Increasingly, CES engineers are involved in the design of computer-based and electrical systems to address highly specialized and specific application needs. CES engineers work in most industries, including the computer, aerospace, telecommunications, power production, manufacturing, defense, and electronics industries. They design high-tech devices ranging from tiny microelectronic integrated-circuit chips to powerful systems that utilize those chips, efficient telecommunication systems that interconnect those systems and versatile software algorithms that leverage these systems to tackle challenging problems facing the world. Applications include consumer electronics, advanced microprocessors, peripheral equipment, mobile/desktop/server computing systems, and communications devices. It also includes distributed computing environments (local and wide area networks, wireless networks, internets, intranets), embedded computer systems (such as aircraft, spacecraft, and automobile control systems in which computers are embedded to perform various functions) and complex, high-performance software and algorithms. A wide array of complex technological systems, such as power generation and distribution systems and modern processing and manufacturing plants, rely on computer systems and software developed and designed by CES engineers. Technological advances and innovation continue to drive CES engineering. There is now a convergence of several established technologies resulting in widespread and ready access to information on an enormous scale. This has created many opportunities and challenges for CES engineers. This convergence of technologies and associated innovations lies at the heart of economic development and the future of our society. The situation bodes well for a successful career in CES engineering.

C.2. Employment Opportunities in Computer and Electrical Systems Engineering

The U.S. Bureau of Labor Statistics (BLS) projects that computer hardware and software engineers holding baccalaureate degrees should see an employment growth of five percent during the 2016-2026 decade. This field is versatile, and professionals can work for industries in telecommunications, software technology or digital hardware. For the foreseeable future, there will be a strong demand for CES engineers as many industries beyond the computer industry will continue to need more computer-based equipment and advanced software that can leverage the capabilities of this equipment. The BLS noted that the overall employment of computer hardware and software engineers was expected to grow 6% between 2018 and 2028. Those who have graduated from a degree program

and who hold experience with a combination of computer hardware and software with a background in electrical engineering should see the greatest opportunities.

C.3. Salaries of Computer and Electrical Systems Engineering Professionals

According to BLS In May 2018, the median annual salary for computer hardware engineers holding baccalaureate degrees was $114,600. The BLS also reported that software applications developers earned median salaries of $103,620, while those in the systems sector received median salaries of $110,000 annually. In addition, BLS reported that electrical engineers earned a median annual salary of $96,640 as of 2018, while systems software developers earned a median wage of
$110,000.

---

[18] https://www.marketresearch.com/One-Off-Global-Market-Insights-v4130/Embedded-Systems-Size-Component-Hardware-13094178/
[19] https://www.emsinet.com
[20] https://www.indeed.com
[21] https://www.payscale.com
[22] http://www.bls.gov

According to Salary.com, the median salary for a software engineer in Baltimore, Maryland is $112,762. Similarly, the median salary for a Computer Engineer, Systems Engineer, and Power Electronics Engineer in Baltimore Maryland is $130,935, $105,061, and $94,063 respectively. All these fields have overall salary ranges between approximately $90,000 and $160,000. It is anticipated that graduates of the program would be positioned on the higher range of these pay scales given the experience they would gain in the Ph.D. /M.S. program and desirability of a degree, which effectively combines multiple highly desirable disciplines, to government (e.g. NSA), academia, and industry (e.g., Google, Amazon, etc.).

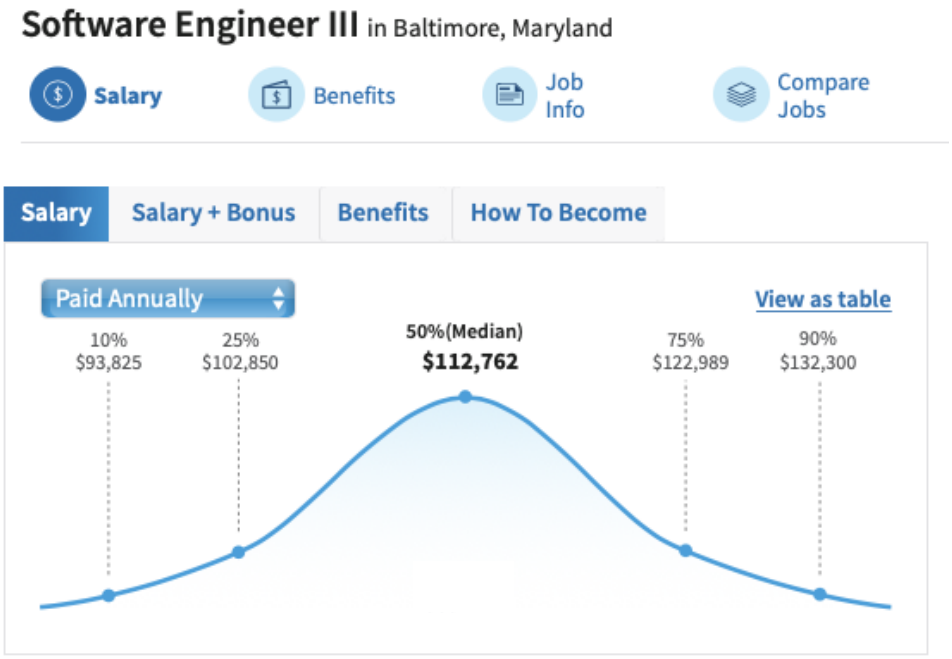

Figure 1: Average salaries of software engineers in Baltimore, Maryland

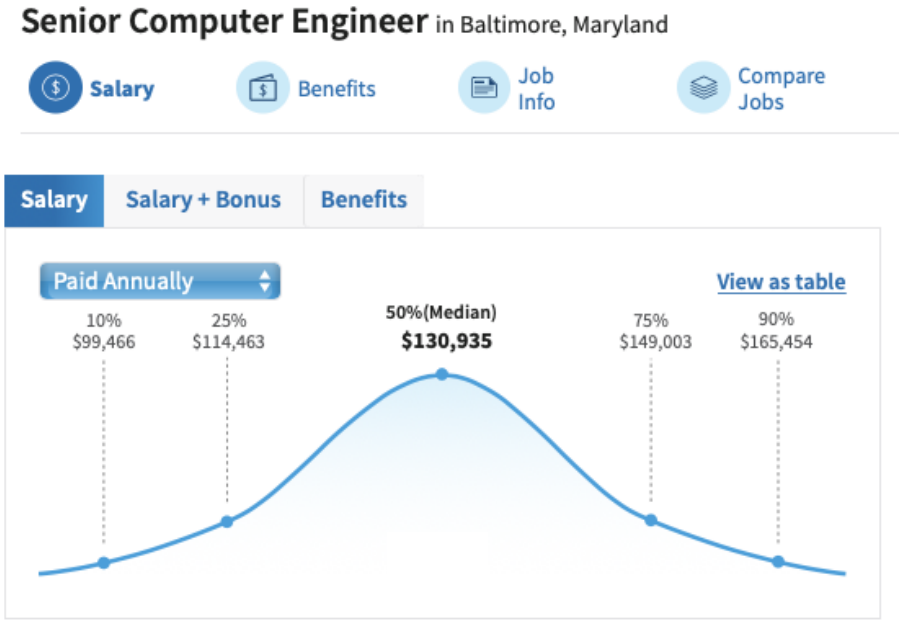

Figure 2: Average salaries of computer engineers in Baltimore, Maryland

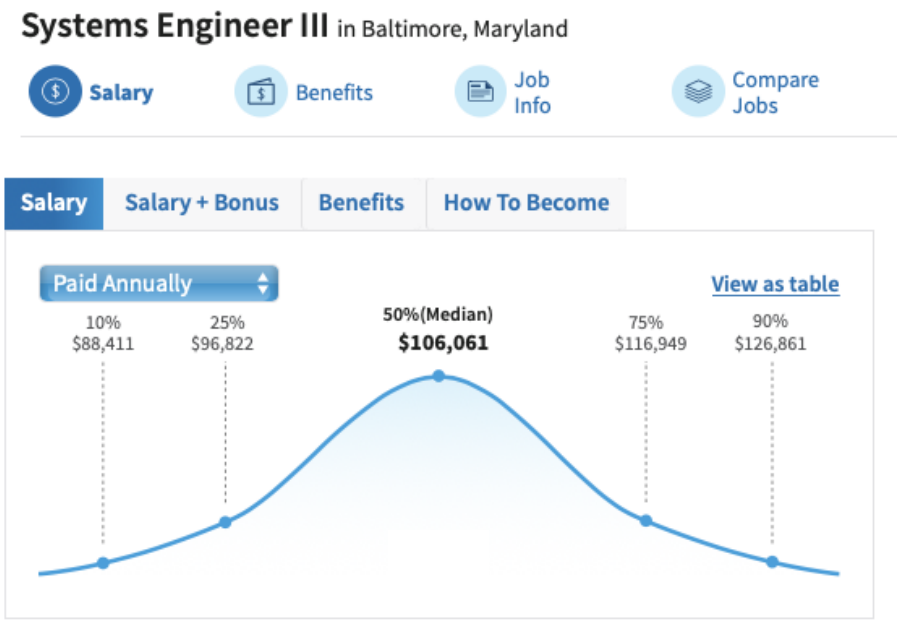

Figure 3: Average salaries of systems engineers in Baltimore, Maryland

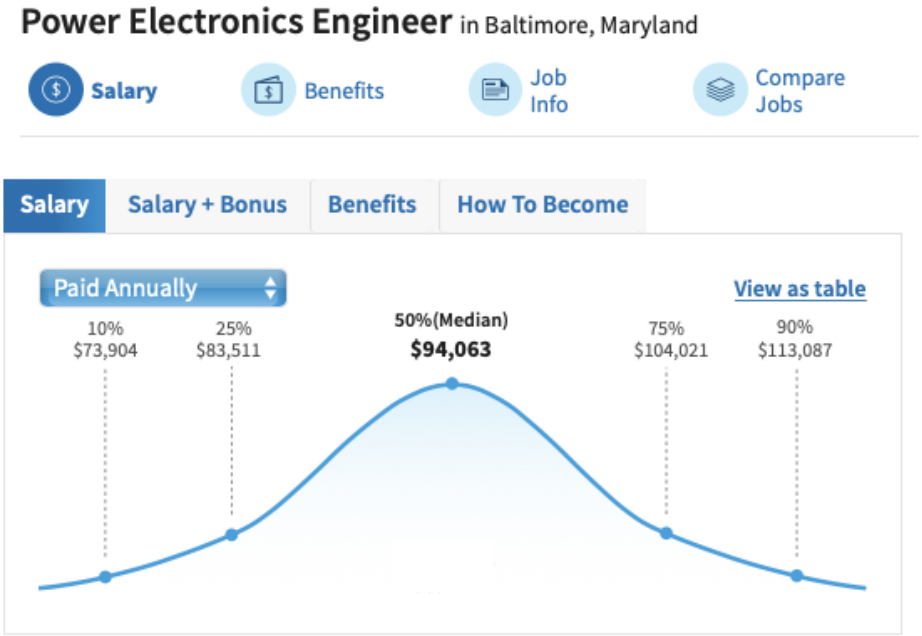

Figure 4: Average salaries of power electronics engineers in Baltimore, Maryland

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 5 shows the science and engineering occupations with the most projected job openings due to growth, labor force exits, and occupational transfers, respectively. The vast majority of the projected jobs are computer occupations. Figure 6 shows the employment of electrical and electronics engineers is projected to grow 7 percent from 2020 to 2030, about as fast as the average for all occupations.

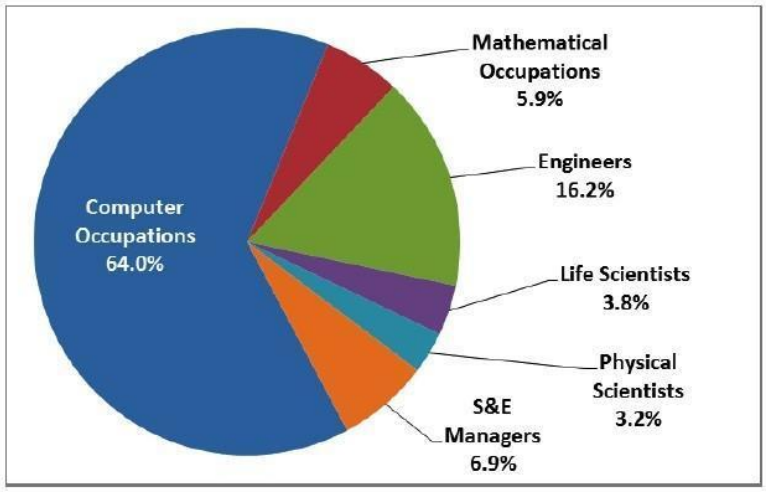

Figure 5: Employment projections from 2016-2026, Bureau of Labor Statistics, U.S. Department of Labor.

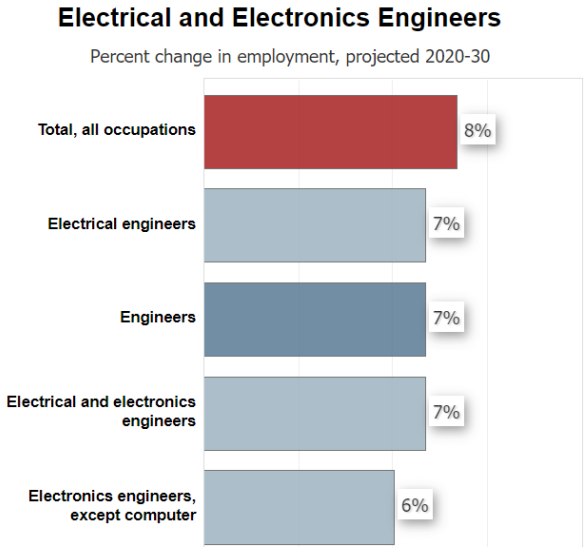

Figure 6: Electrical and Electronic engineering projected job openings due to growth labor force exits and occupational transfers from 2020-2030.

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

D. Reasonableness of Program Duplication

D.1. Similar Programs

The proposed Ph.D. /M.S. in Computer and Electrical Systems Engineering program is not a duplication of effort, and according to our findings, there are no comparable Ph.D. programs in the State of Maryland that are focused on or are named Computer and Electrical Systems Engineering. The focus of this program is not specific to sub-disciplines in Electrical and computer engineering but emphasizes an open, systems-level, problem-solving approach employing computer and electrical systems engineering techniques, theoretical concepts, and interdisciplinary thinking. Furthermore, preparing the graduates of this program involves the bookend model that assures all candidates are vetted and well received by their peers.

D.2. Justification for Proposed Program

There is no program named Ph.D. in Computer and Electrical Systems Engineering in the State of Maryland, and there is a great opportunity and need for professionals in this space as supported by the data provided in the aforementioned sections. With a combination of diverse disciplines, integrated experiential learning, and complemented by strong research activities within an urban setting, graduates from the Program will be employed by industry and will profoundly contribute to the industrial and economic base of the greater Baltimore-Washington metropolitan area and beyond.

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

To date, there are no equivalently named 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. /M.S. program in Computer and Electrical Systems Engineering will not have any negative impact on the State's HBIs.

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 2019. Morgan's undergraduate and graduate student populations are roughly 80% African-American. Morgan is committed to the academic success and achievement of all students. None of the other HBIs have a Ph.D. /M.S. program in Computer and Electrical Systems 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 Hungtao Yu provided. 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 ECE department and encompasses the research expertise/capabilities and graduate courses taught by the ECE faculty. It leverages most of the existing courses within the Doctor of Engineering program and introduces new courses designed to integrate knowledge across software, hardware, and electrical systems domains. The Program will be offered by the Department of Electrical and Computer Engineering.

G.1.2. Program Oversight

The Electrical and Computer Engineering (ECE) Graduate Coordinator, who also serves as liaison with Graduate Admissions for the Program, will oversee the Ph.D. /M.S. Program with duties such as reporting to the ECE Department Chair, scheduling graduate classes, data gathering, program assessment, registration, retention, recruitment, marketing and program development.

G.2. Educational Objectives and Learning Outcomes

G.2.1. Program Objectives

The Program mainly targets highly motivated students who have already obtained the Bachelor's or Master's degree and who also wish to pursue careers in research, university teaching, consulting or management positions 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 problems related to engineering grand challenges that require the fusion of computer software, hardware and electrical systems. Specifically, upon completing the Program, students will be expected to:

1. Depending on their topical dissertation area, demonstrate a breadth of knowledge in advanced electrical engineering systems, circuits, components or materials;
2. Mastery of fundamental concepts in mathematical system theory, principles of engineering, planning and/or management in solving complex engineering problems;
3. Conduct independent research and disseminate research results through peer-review and publication;
4. Communicate difficult technical concepts both orally and in writing and function on an interdisciplinary team, particularly in a laboratory setting; and
5. Teaching or mentoring other students in the classroom or directed research activities under faculty supervision.

G.3. Program Evaluation

The assessment of this program will be administered by the University's Office of Assessment which supports the strategic initiatives of Morgan State University by directing the implementation of the Comprehensive Assessment Plan and the General Education Program. The Office works with University Divisions to collect, analyze, report on and use data related to institutional effectiveness, accreditation, student success, satisfaction and retention; and campus performance against key benchmark indicators.

G.4. Course Descriptions & Program Requirements

G.4.1. Admission Requirements

The Program welcomes exceptional students with at least a 3.0 cumulative GPA (on a scale of 4.0) for all undergraduate and graduate work completed. Other requirements include a resume or curriculum vitae documenting current and previous professional activities, achievements, planned career goals, a statement of research interest, and three letters of recommendation from professors or supervisors familiar with the applicant's academic background. All application materials must be sent directly to the School of Graduate Studies through the application system for preliminary screening. Eligibility to be a student within 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 by the end of the first year after admission, comprising 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 ECE department. A minimum of two ECE faculty must serve on the committee. The students form an advisory committee no later than the end of the first year. The committee approves the student's program of study and guides the student's research activities;
2. Complete a minimum of 36 graduate credit hours (including 9 hours of dissertation-related research) of study beyond the Master's degree or complete a minimum of 60 graduate credit hours of study beyond the bachelor's degree (with a maximum of 33 hours of dissertation-related research).
3. Pass a written qualifying exam within the first two years of study (one attempt within the first year), doctoral candidacy examinations (no sooner than a year after passing the qualifying exam), administered by the dissertation committee, on the Foundational course subjects;
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 Electrical Engineering within the seven years of enrollment;
6. The dissertation committee chair must determine the original contribution of the dissertation work.

The qualifying exam is at the level of advanced undergraduate courses and introductory graduate-level courses. To maintain good academic standing and remain in the Program, the student may not have course grades lower than B in any of the required Foundational courses 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. in Electrical 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) from other accredited institutions may be accepted for transfer towards the Ph.D. degree, assuming that students do not use transfer courses to satisfy the academic requirements of the former program. Transfer courses at a grade of B or above are approved by the corresponding department.

Foundational Elective Courses (8)	24 credits
Research Courses (5)	15 credits
Graduate Seminar (1)	3 Credits
Dissertation Research (5)	15 credits
Dissertation Defense EEGR 998 (1)	3 Credits
Total	**60 credits**

Table A: Credit breakdown for students pursuing a Ph.D. directly from the Bachelor's Degree (60 credits required beyond a Bachelor's Degree).

Foundational Elective Courses *or* Research Courses (5)	15 credits
Graduate Seminar (1)	3 Credits
Dissertation Research (5)	15 credits
Dissertation Defense EEGR 998 (1)	3 Credits
Total	**36 credits**

Table B: Credit breakdown for students pursuing a Ph.D. directly from the Master's Degree (36 credits required beyond a Master's Degree).

Masters in Electrical Engineering, Computer Science, or Computer Engineering
Masters in Software Engineering
Masters in Information Systems, Mathematics, or Physics

Table C: List of approved Masters Degree programs for direct admission to the Ph.D. program

Students with a master's degree in the approved areas listed in Table C, or a related discipline will be required to take a minimum of 15 credits of Foundational elective and/or research courses, 3 credits of Graduate Seminar, 15 credits of Dissertation Research and 3 credits of Dissertation Defense (EEGR 998). However, students with degrees in information systems, mathematics or physics are encouraged, with the observation that such students will be conditionally admitted to the program and they may also be required to complete some Foundational elective courses to gain an adequate background in electrical and computer engineering, and such requirements are dealt with on an individual basis. For those admitted 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 C will be required to take a minimum of 8 Foundational elective courses totaling 24 credits, and 15 credits of Dissertation Research and 3 credits of Dissertation Defense (EEGR 998), as well as the Graduate Seminar and Research courses, to make a total of 60 credits on completion. Students in the bachelor's to Ph.D. track will receive an *en passant*, or "along-the-way," master's degree, Master of Science in Computer and Electrical Systems Engineering after completing 30 credits in

the program. These 30 credits must include 24 credits of Foundational elective courses. Students are limited to a maximum of three 500-level courses. Foundational elective courses are a combination of ECE and non-ECE elective courses that are determined to be of key importance in building the necessary rigor and breath through coursework needed to pursue a dissertation topic. Example Foundational elective topical areas may relate to but are not limited to: Communications, Signal Processing, RF and Millimeter wave Systems, Computer Engineering, Control Systems, Electronic Materials, and Power Systems. Students can also have outside elective courses as approved by the Program Director. Any non-research EEGR graduate course at the 500 – 700 level that is listed in section G.4.5 can serve as a Foundational Elective course.

Research Course Numbers & Course Titles	Credits
EEGR 805 - Pre-Candidacy Research I	3.0
EEGR 810 - Pre-Candidacy Research II	3.0
EEGR 815 - Pre-Candidacy Research III	3.0
EEGR 820 - Pre-Candidacy Research IV	3.0
EEGR 825 - Pre-Candidacy Research V	3.0
EEGR 830 - Pre-Candidacy Research VI	3.0

Table D: Research Courses before Ph.D. Candidacy

Dissertation Research Course Numbers & Course Titles	Credits
EEGR 905 - Dissertation Research I	3.0
EEGR 910 - Dissertation Research II	3.0
EEGR 915 - Dissertation Research III	3.0
EEGR 920 - Dissertation Research IV	3.0
EEGR 925 - Dissertation Research V	3.0
EEGR 997/998 - Dissertation Guidance/Defense	3.0

Table E: Dissertation Research Courses including Dissertation Defense

Note that the student is eligible to take the Dissertation Research courses listed in Table D, only after he/she has passed the Dissertation Proposal Exam (A) and been 'Advanced to Candidacy'. Prior to this, the Research courses in Table E must be used. A student who has completed all required course credits but who has not Advanced to Candidacy, should register for the EEGR 993 (Pre-Candidacy course). Students are expected to submit at least three articles for publication before completion of their program, and they will finish the Ph.D. program with EEGR 997/ 998 (Dissertation Guidance/Defense) The academic advisor has the discretion to substitute a quality archival journal publication in the place of the three articles being submitted.

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 EEGR 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 EEGR 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 EEGR 998 (Dissertation Defense) for the given semester and count for 3 credit hours of curricular coursework (EEGR 998 will also count as 9 credits of load). EEGR 997 will not count toward curricular credits. Other courses cannot be substituted for EEGR 997 (Dissertation Guidance). The only eligible grade for EEGR 997 (Dissertation Guidance) is the grade of "S" and the only acceptable grade for EEGR 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 Electrical Engineering.

Plan I: *For students holding only a bachelor's degree pursuing a Ph.D. in Computer and Electrical Systems Engineering (60 credits)*

		First Semester	Credits		Second Semester	Credits
YEAR 1	EEGR 787	GRADUATE SEMINAR	3	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3
	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3
	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3
	TOTAL		**9**	**TOTAL**		**9**
YEAR 2	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3
	EEGR xxx	FOUNDATIONAL ELECTIVE COURSE	3	EEGR 810	RESEARCH COURSE	3
	EEGR 805	RESEARCH COURSE	3	EEGR 815	RESEARCH COURSE	3
		TAKE QUALIFYING EXAM				
	TOTAL		**9**	**TOTAL**		**9**
		After Successful completion of all credits, the student is awarded the en Passant Masters degree				
YEAR 3	EEGR 820	RESEARCH COURSE	3	EEGR 905	DISSERTATION RESEARCH I	3
	EEGR 825	RESEARCH COURSE	3	EEGR 910	DISSERTATION RESEARCH II	3
				EEGR 915	DISSERTATION RESEARCH II	3
		SUBMIT PAPER # 1			*SUBMIT PAPER # 2*	
		CANDIDACY PROPOSAL EXAM (A)				
	TOTAL		**6**	**TOTAL**		**9**
YEAR 4	EEGR 920	DISSERTATION RESEARCH IV	3	EEGR 997/998	DISSERTATION GUIDANCE/DEFENSE	3
	EEGR 925	DISSERTATION RESEARCH V	3			
		SUBMIT PAPER # 3			***DISSERTATION DEFENSE EXAM (B)***	
					COMPLETE & SUBMIT DISSERTATION	
	TOTAL		**6**	**TOTAL**		**3**
		BS –> Ph.D., ELECTRICAL ENGINEERING			**TOTAL CREDIT HOURS**	**60**

Table F: 60-credit Plan for students holding only a bachelor's degree pursuing a Ph.D. in Computer and Electrical Systems Engineering

First Semester (9 Credits)

- Graduate Seminar 3 credits
- Foundational Elective Course 6 credits

Second Semester (9 Credits)

- Foundational Elective Course 9 credits

Third Semester (9 Credits)

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

Fourth Semester (9 Credits)

- Foundational Elective Course 3 credits
- Research Course 6 credits

Fifth Semester (6 Credits)

- Research Courses 6 credits
- *Submit Paper 1*
- *Take Candidacy Exam (A Exam)*

Sixth Semester (9 Credits)

- Dissertation Research 9 credits
- *Submit Paper 2*

Seventh Semester (6 Credits)

- Dissertation Research 6 credits
- *Submit Paper 3*

Eighth Semester (3 Credits)

- Dissertation Defense (997/998) 3 credits
- *Take Dissertation Defense Exam B*

Total Credits = 60

Plan II: *For students with a master's degree pursuing a Ph.D. in Computer and Electrical Systems Engineering (36 credits)*

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

Table G: 36-credit Plan for students with an approved Master's degree pursuing a Ph.D. in Computer and Electrical Systems Engineering

First Semester (9 Credits)

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

Second Semester (9 Credits)

- Foundational Elective/Research Course 9 credits
- *Submit Paper 1*
- *Take Candidacy Proposal Exam A*

Third Semester (9 Credits)

- Dissertation Research 9 credits
- *Submit Paper 2*

Fourth Semester (6 Credits)

- Dissertation Research 6 credits
- *Submit Paper 3*

Fifth Semester (3 Credits)

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

Total Credits = 36

G.4.5. Course Descriptions

EEGR 503: Communications Theory - Three Hours: 3 Credits
This course introduces students to the basic concepts in communication theory. It includes an introduction to analog AM and FM modulation, digital modulation, baseband and bandpass digital communication, communication link analysis, channel coding, modulation and coding trade-offs.

EEGR 505: Advanced Engineering Mathematics with Computational Methods - Three Hours: 3 Credits
Advanced math topics including matrix analysis, vector and tensor calculus and complex variables. Infinite series expansions and their use as solutions of variable coefficient differential equations. Partial differential equations, nonlinear differential equations and systems of differential equations.

EEGR 507: Applied Probability and Statistical Analysis - Three Hours: 3 Credits
Modeling and analysis of random processes. Random variables, transforms, and their probability laws will be covered Probability assessment and decision analysis. Applications using numerical methods.

EEGR 508: Advanced Linear Systems - Three Hours: 3 Credits
This course focuses on fundamental concepts for the analysis of linear systems in the discrete and continuous domains. Matrix representations of linear operators, eigenvector-eigenvalue analysis, and the Cayley-Hamilton theorem will be covered.

EEGR 510: Communications Networks - Three Hours: 3 Credits
An introduction to communication networks. Includes the OSI layering model of networks with emphasis on the physical, data link, and network layers; and network topologies. Introduction to a variety of networks, including Ethernet, wireless LAN, and cellular.

EEGR 520: Digital Image Processing - Three Hours: 3 Credits
This course covers topics relevant to the understanding, feature extraction, and modification of images. Topics include 2-D system theory, image transforms, image analysis, image enhancement and restoration, image coding, automatic pattern recognition, image processing hardware and software.

EEGR 522: Digital Signal and Speech Processing - Three Hours: 3 Credits
The course covers of digital signal processing and an introduction to techniques for speech signal processing. Includes: linear predictive coding (LPC), pattern recognition, compression, speech physiology, and other topics of interest.

EEGR 524: Introduction to Radar - Three Hours: 3 Credits
A course in the fundamentals of radar system engineering. The radar range equation, radar transmitters, antennas, and receivers are covered. Concepts of matched filtering, pulse compression, and fundamentals of radar target detection in a noise background are discussed.

EEGR 531: Linear Control Systems - Three Hours: 3 Credits
This course deals with the analysis of time and frequency response of closed loop systems, Routh-Hurwitz and Nyquist criteria for stability, Root locus method, and System specifications.

EEGR 532: Microwave Transmission - Three Hours: 3 Credits
A course in the fundamental concepts of Maxwell's equations, wave propagation, network analysis, and design principles. Topics include planar transmission lines, bipolar and field effect transistors, dielectric resonators, low-noise amplifiers, transistor oscillators, PIN diode control circuits and monolithic integrated circuits.

EEGR 534: Microwave System and Components - Three Hours: 3 Credits
This course provides the practical aspects of microwave systems and components. Overview of communication and radar systems is followed by detailed analysis of key components. Topics include linear and nonlinear characteristics of individual components and their relationship to system performance.

EEGR 535: Active Microwave Circuit Design - Three Hours: 3 Credits
This course will provide a brief overview of Smith Charts and transmission line theory, microstrip lines, and impedance matching. It will introduce power gain equations, stability considerations, and solid-state microwave circuits such as amplifiers, oscillators, active mixers, attenuators, and frequency multipliers.

EEGR 536: Antenna Theory and Design - Three Hours: 3 Credits
This course deals with the analysis and design of basic antenna structures such as linear dipoles, antenna arrays, horns, and patch antennas. Computer-aided design software will be used to optimize antenna performance, placement of feeds, and gain.

EGR 537: Radio Frequency Integrated Circuit Design - Three Hours: 3 Credits
A course in the design and analysis of radio-frequency integrated circuits using state-of-the-art complementary metal-oxide-semiconductor (CMOS) and bipolar technologies. It focuses on system-level trade-offs in transceiver design, practical radio-frequency circuit techniques, and a physical understanding of device parasitic components.

EEGR 540: Solid State Electronics - Three Hours: 3 Credits
This course will focus on the fundamentals of solid-state physics for electronic materials and devices.
Discussion of core topics including three-dimensional bulk material properties and recent developments in low-dimensional semiconductor structures, such as heterostructures, superlattices and quantum wells are covered.

EEGR 542: Microwave Power Devices - Three Hours: 3 Credits
This course introduces microwave power devices and circuits including amplifiers, P-i-N and Schottky power rectifiers, power MOSFETs, conductivity-modulated high-power devices, wide band gap semiconductors, and emerging material technologies in relation to device modeling.

EEGR 543: Introduction to Microwaves - Three Hours: 3 Credits
This course deals with electromagnetic wave types, transmission lines and waveguides, Smith Chart, S-parameters, and passive components associated with microwave signals and circuits.

EEGR 550: Fundamentals of Energy and Power Systems - Three Hours: 3 Credits
This course will provide a high-level overview of energy and power from a systems perspective. Major components of power systems and the technical specifications in relation to various industries will be explored.

EEGR 551: Digital Signal Processing - Three Hours: 3 Credits
This course provides an emphasis on applications of digital signal processing. It includes the theory and application of the discrete Fourier transform, Fast Fourier transform, sampling, quantization, and digital filter design.

EEGR 553: Electric Drives and Machines - Three Hours: 3 Credits
This course provides an integrated approach to electric drives and subsystems that make up electric drives: electric machines, power electronics converters, mechanical system requirements, feedback controller design, and the interaction of drives with the utility grid.

EEGR 554: Renewable Energy Systems - Three Hours: 3 Credits
This course provides a multidisciplinary approach that encompasses economic, social, and environmental, policy, and engineering issues related to renewable energy. The renewable systems covered will be solar PV, solar thermal, geothermal, bioenergy, wind, and hydroelectric.

EEGR 555: Advanced Power Electronics - Three Hours: 3 Credits
This course provides an approach to the design power electronic converters. Topics include state average modeling, inverter design, resonant converters, snubber circuits, and feedback control design.

EEGR 556: Modeling and Control Techniques in Power Electronics - Three Hours: 3 Credits
The objective of this course is to provide the theory of control technology with various control strategies to effectively control power systems. Microprocessors and control algorithms based on PWM will be investigated in relation to switching devices and feedback control.

EEGR 557: Smart Grid and Building Energy Efficiency - Three Hours: 3 Credits
This course provides a comprehensive approach towards smart grid that encompasses sensors, communications technologies, computational ability, control, and feedback mechanisms that effectively combined to create the smart grid system.

EEGR 560: Computer Networks - Three Hours: 3 Credits
ISO open systems reference model, protocol layers, TCP/IP, channel coding, data communication concepts, local area network (LAN) topologies and transmission media, queuing theory applied to LAN performance modeling, LAN access techniques, network interconnection, network reliability, and network security

EEGR 562: Computer Architecture, Networks, and Operating Systems - Three Hours: 3 Credits
Quantitative basis of modem computer architecture, processor designs memory hierarchy, and in-put/output methods. Layered operating system structures, process and storage management Layered network organization, network protocols, switching, local and wide area networks. Examples from Unix and the Internet.

EEGR 565: Machine Learning Applications - Three Hours: 3 Credits
This course provides a broad introduction to machine learning and statistical pattern recognition. The course explores current applications of machine learning, such as to robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing

EEGR 570: Advanced Digital System Design - Three Hours: 3 Credits
Introduces alternative means by which a logic system. Reviews logical factors of digital systems and the architecture of FPGAs along with the options and trade-offs for diverse approaches. Small and modest sized design implementations on different FPGA architectures are covered.

EEGR 571: Embedded Hardware Security - Three Hours: 3 Credits
Design and implementation of secure embedded hardware, covering cryptographic hardware primitives, cryptographic modules, and trusted platforms. Reverse engineering of embedded hardware using passive and active attack techniques. Countermeasures against reverse engineering.

EEGR 575: Software Engineering: Systems Implementation - Three Hours: 3 Credits
Implementation aspects of software engineering; Programming languages; architectural designs; program design; structured programming; peripheral storage devices; I/O programming, debugging and evaluation.

EEGR 580: Advanced Cyber Security - Three Hours: 3 Credits
This course will provide an introduction to cyber-security including threats, vulnerabilities, attacks, operating system security, databases, secure software and system development, business, policy and procedures, security management, and legal issues. This serves as the introduction to the cyber security program.

EEGR 581 Advanced Network Security - Three Hours: 3 Credits
This course will provide an introduction to the architecture and components of secure IT networks. It includes the fundamentals of network architecture, vulnerabilities, and security mechanisms including firewalls, guards, intrusion detection, access control, malware scanners and biometrics.

EEGR 582: Advanced Cryptography - Three Hours: 3 Credits
This course will provide a background in the many aspects of communications security associated with link and internet applications. It includes the fundamentals of number theory, cryptography, public and private key structures, digital signature and secure hash functions.

EEGR 583: Advanced Security Management - Three Hours: 3 Credits
This course will provide a background in the many aspects of security management associated with communications and networks. It includes the fundamentals of Risk Analysis, Risk Management, Security Policy, Security Operations, Forensics, Legal issues, Business issues and Secure Systems Development.

EEGR 605: Digital Communications - Three Hours: 3 Credits
This course provides a brief review of signals, probability, stochastic processes and information theory followed by the development of source encoding, modulation systems, optimum receiver design, demodulation systems, and error correction coding.

EEGR 607: Information Theory - Three Hours: 3 Credits
This course presents measures of information, information sources, coding for discrete sources, the noiseless coding theorems, Huffman coding, channel capacity, the noisy-channel coding theorems and applications to gambling and investing.

EEGR 608: Error Control Coding - Three Hours: 3 Credits
This course includes a review of information theory with the theory and design of error detection and correction schemes. Includes block and convolutional codes, interleaving, ARQ schemes, error detection schemes, and a variety of applications on wired and wireless networks.

EEGR 610: Wireless Communications - Three Hours: 3 Credits
This course presents current techniques on wireless digital communications, such as wireless channel modeling, channel distortion due to multipath and Doppler, digital modulation and demodulation (MODEM) techniques, and cellular multiple access methods including TDMA, FDMA and CDMA systems.

EEGR 612: Multi User Communications - Three Hours: 3 Credits
Review of network architectures using OSI layering strategies. Includes Queueing theory application to various queues; and reservation, polling, and token passing systems. Protocol designs for radio multi-channel networks with various contention strategies. Local area network protocols, performance and strategies.

EEGR 614: Queueing Networks - Three Hours: 3 Credits
Addresses the fundamentals of stochastic processes and queuing theory. Includes Poisson processes, Markov chains, renewal processes, tandem queues, networks of queues, priority and bulk queues, computational methods, and simulation. Application and performance with a variety of computer and communications applications.

EEGR 615: High Speed Networks - Three Hours: 3 Credits
Introduction to high data rate design and integrated services protocols multi-media low latency applications such as video, voice, and data internet traffic. The QoS techniques for TCP/IP, and Asynchronous Transfer Mode (ATM). Introduction to Routing and Queuing Theory is included.

EEGR 620: Digital Image Processing - Three Hours: 3 Credits
This is an introduction course on the fundamentals of digital image processing with an emphasis on signal processing. Topics included: image formation, images transforms, image enhancement image restoration, image reconstruction, image compression, image segmentation and image representation.

EEGR 622: Adaptive Signal Processing - Three Hours: 3 Credits
Emphasizes the theory and design of finite-impulse response adaptive filters including stochastic processes, Weiner filter, steepest descent, adaptive filters using gradient-methods, analysis of the LMS algorithm, least--squares methods, recursive least squares, and least squares lattice adaptive filters.

EEGR 623: Pattern Recognition - Three Hours: 3 Credits
This course addresses the general pattern classification problem. It includes: statistical decision theory, multivariate probability functions, discriminants, parametric and nonparametric techniques, Bayesian and maximum likelihood estimation, feature selection, dimensionality reduction, transformations, and clustering.

EEGR 624: Detection and Estimation Theory - Three Hours: 3 Credits
This is a course on statistical decision theory, modeling of signals and noise, detection of various signals, and statistical estimation theory. Includes decision criteria, hypothesis testing, receiver operating characteristics, detection of signals with unknown parameters, performance measures, and optimum demodulation.

EEGR 625: Optical Communication - Three Hours: 3 Credits
Includes the characteristics of light as used in communications systems including propagation of rays in waveguides, scalar diffraction theory, optical information processing systems, quantum statistical communication theory, heterodyning and receivers.

EEGR 626: Optimization/Numerical Methods - Three Hours: 3 Credits
This course investigates classical deterministic optimization techniques and stochastic optimization techniques. The classical techniques will include linear and non-linear programming, steepest descent, and Newton-Raphson methods. Stochastic methods will include Robbins-Monro gradient-based stochastic approximation and the simultaneous perturbation stochastic approximation algorithms.

EEGR 633: Automated Measurements, Devices and Systems - Three Hours: 3 Credits
Students will be introduced to the fundamentals of high-frequency measurements and techniques for accuracy-enhanced microwave measurements. Automated network analyzers and high-speed wafer probes are used in conjunction with state-of-the-art calibration techniques. Non-linear modeling of active devices will be introduced.

EEGR 634: Computational Electromagnetics - Three Hours: 3 Credits
The finite-element method (FEM), the finite-difference (FD), the finite-difference-time-domain (FDTD), and the method of moments (MoM) are covered. This course will focus on several electromagnetic field equations, such as Laplace's, Poisson's, and Helmholtz's equations, and the related numerical techniques.

EEGR 635: Advanced Electromagnetic Theory - Three Hours: 3 Credits
This course is an introductory course in electromagnetic theory and applications. Topics include Stokes parameters, Poincare sphere, gyrotropic media, uniaxial media, phase matching, layered media, dielectric waveguides, metallic waveguides and resonators, Cerenkov radiation, Hertzian dipole, equivalence principle, and reciprocity.

EEGR 636: Quantum Mechanics - Three Hours: 3 Credits
This is a survey course on quantum mechanics that covers Lagrangian and Hamiltonian equations, Schrodinger equation, wave packets, particle in a box, tunneling of particles, Dirac's description of quantum mechanical states and matrix formulation of quantum mechanics, and perturbation theory.

EEGR 637: Advanced Antenna Theory - Three Hours: 3 Credits
This course develops fundamental concepts used to analyze basic antenna systems. Topics include antenna patterns, optimum designs for rectangular and circular apertures, arbitrary side lobe topography, discrete arrays, mutual coupling, and feeding networks.

EEGR 640: Advanced Solid State Electronics - Three Hours: 3 Credits
This course will focus on the fundamentals of solid-state physics as it applies to electronic materials and devices. Heterostructures, superlattices and quantum wells will be covered. Additionally, various material growth and device fabrication techniques will be discussed.

EEGR 642: Semiconductor Fabrication Technology - Three Hours: 3 Credits
Overview of the fundamental principles of semiconductor fabrication technology is presented. Topics include basic material review; methods of oxidation; methods of deposition/diffusion and ion implantation, principles of epitaxial deposition/ growth, photolithographic technology, chemical vapor deposition/nitride, silicon dioxide, and metallization technology.

EEGR 643: Advanced Semiconductor Characterization - Three Hours: 3 Credits
This course is an advanced approach to the measurement of physical principles underlying semiconductor device operation. Topics include measurement techniques of physical parameters in semiconductor material and device structures: impurity profiling, carrier transport, and deep and shallow level trap characterization.

EEGR 645: Optical Engineering - Three Hours: 3 Credits
This course presents the engineering concepts to understand and evaluate optical systems using practical examples of optical instruments and electro-optical systems. Other topics include polarization, interference, diffraction, and optical properties of crystals, thin-films, optical resonators, guided waves, modulators and detectors.

EEGR 646: Optical Communication - Three Hours: 3 Credits
This course provides an overview of communication systems, light and electromagnetic waves, optical fibers, lasers, LED, photodetectors, receivers, optical fiber communication systems.

EEGR 650: Physical Layer Hardware Design - Three Hours: 3 Credits
Course focuses on the development of embedded systems for wireless communications. The course requires the students to design DSP cores for wireless protocols. The student will learn how to use tools, frameworks, and hardware platforms for PHY waveform design.

EEGR 660: Computer Architecture and Design - Three Hours: 3 Credits
Principles and advanced concepts and state-of-the-art developments in computer architecture: memory systems, pipelining, instruction-level parallelism, storage systems, multiprocessors, relationships between computer design and application requirements, cost/performance tradeoffs, and architectures for DSP applications.

EEGR 662: Parallel Processing Architecture - Three Hours: 3 Credits
This course addresses fundamental issues in the design and use of large-scale multiprocessors. Both software and hardware issues are addressed. Topics include parallel applications, parallel programming languages, design of multiprocessors, parallelism, memory system design, and interconnection networks.

EEGR 664: Introduction to Parallel Computation - Three Hours: 3 Credits
Motivation for parallel processing, technological constraints, complexity, performance-characterization, communications, interconnection networks, memory systems, on-line visualization, coarse and fine-grain processor design, finite-difference and finite-elements, parallel optimization and transformation algorithms, selected signal and image processing applications, and selected architecture.

EEGR 666: Parallel Algorithms - Three Hours: 3 Credits
The design and analysis of efficient algorithms for parallel computers. Fundamental problem areas, such as sorting, matrix multiplication, and graph theory, are considered for a variety of parallel architectures.

EEGR 668: Topics in Networking and Network Applications - Three Hours: 3 Credits
Discussion on how existing and emerging data communication technologies: LAN and WAN Technologies, Bridging, Switching, Routing, Networking Protocols, Management, Design and Security as well as Multicast, Videoconferencing, Multimedia Collaboration Technologies and Audio/Video compression and coding.

EEGR 670: DSP VLSI Design - Three Hours: 3 Credits
DSP VLSI architecture and algorithms; design strategies; design methodologies; system-level design; area/delay/power trade-offs; high performance systems; multi-chip modules; low-power design; hardware/software co-design; design for testability, design for manufacturability; algorithm, architecture, and component design for adaptive computing systems.

EEGR 672: Computer Graphics - Three Hours: 3 Credits
Overview of computer graphics with emphasis on high performance hardware and software techniques to model, render and display computer imagery. Topics include: geometric and raster algorithms, curves and surfaces, object hierarchy, display technologies, video controllers and processors, and input devices.

EEGR 675: Computer Vision - Three Hours: 3 Credits
Image formation and visual perception. Images, line structure, and line drawings. Preprocessing, boundary detection, texture, and region growing. Image representation in terms of boundaries, regions, and shape. Three-dimensional structures and their projections. Analysis, manipulation, and classification of image data.

EEGR 677: Object Oriented Analysis and Design: Modeling, Analysis, and Optimization of Embedded Software - Three Hours: 3 Credits
Modeling, Analysis, and Optimization of Embedded Software. Current techniques in software engineering with topics selected from economics, reusability, reliable software, program analysis, reverse engineering, CASE tools, automatic code generation, and project management techniques.

EEGR 678: Network Security - Three Hours: 3 Credits
This course will provide a background in aspects of security associated with the protection of computer networks It includes Network attacks and advanced topics in vulnerabilities, networks security management, firewalls, guards, intrusion detection, access control, malware scanners and biometrics.

EEGR 679: Security in Network and Link Applications - Three Hours: 3 Credits
Development of advanced cryptographic elements for internet applications. Advanced number theory, cryptography, Public and Private keys, Elliptic Curves, IPSEC and TLS applications, Quantum cryptography, quantum computing, Bitcoin.

EEGR 680: Switching Theory: High Speed Networks - Three Hours: 3 Credits
This course reviews the development and performance of state-of-the-art switching architectures of broadband networks. Of particular interest will be networks based on the ATM standard for flexibility in providing integrated transmission of sound, image and data signals.

EEGR 682: Design Patterns of Object-Oriented Software Systems - Three Hours: 3 Credits
This course introduces students to the principles of design patterns applied to the design of complex systems. It covers foundational patterns, creational pattern types, structural pattern types, behavioral pattern types, and applications of design patterns.

EEGR 684: Machine Learning Algorithms - Three Hours: 3 Credits
This course introduces students to the principles of machine learning to solve complex computational engineering problems. Topics to be covered include neural networks, evolutionary algorithms, and swarm intelligence.

EEGR 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; dynamic programming, H-2 and H infinity optimal linear sampled-data control, realization of microcomputer real-time control systems.

EEGR 691: Nonlinear Control Systems - Three hours lecture: 3 credits.
This course studies the analysis and design of nonlinear feedback control systems. Topics include: Lyapunov stability, Input-Output Stability of Perturbed Systems, Model- reference adaptive control, sliding mode control, Lyapunov redesign methods, backstepping, and feedback linearization.

EEGR 692: Optimal Control - Three hours lecture: 3 credits.
Optimal control is concerned with the synthesis of feedback control laws that minimize some specified measure of control system performance. This course is a rigorous introduction to the classical theory of optimal control. The topics covered by this course include: 1) the calculus of variations, 2) Pontryagin's principle, 3) dynamic programming, and 4) stochastic dynamic programming.

EEGR 693: Stochastic Control Theory - Three hours lecture: 3 credits.
Optimal control in the presence of process noise. Cost as a random variable. Minimizing average cost over many realizations of random processes. Optimal control when the system will operate only a small number of times. Distribution of the cost. Description of stochastic cost by moments or by cumulants. Optimal stochastic control of cost cumulants. Application to the protection of buildings from earthquakes.

EEGR 694: Hybrid Dynamical Systems - Three hours lecture: 3 credits.
Many physical, biological, social and economic systems may be modeled as hybrid dynamical systems that include both time and event-driven dynamics. The course will introduce students to hybrid control systems including supervisory control of discrete event systems and switched control systems.

EEGR 696: System Identification and Adaptive Control - Three hours lecture: 3 credits.
Theory and methods of system identification and adaptive control. Identification of linear-in-parameter systems, using recursive least-square and extended least square methods, model order selection. Indirect and direct adaptive control. Controller synthesis, transient and stability properties.

EEGR 710: Wireless Communications II - Three Hours lecture: 3 Credits
This is an advanced topic in wireless including: wireless networks, spread spectrum, wireless protocols, LTE/5G cellular, OFDM, and MIMO techniques. Applications include cellular, wireless LAN, ad hoc networks, and wireless internet.

EEGR 735: Advanced Digital VLSI - Three hours lecture: 3 credits
Design methodologies for digital systems using a modern hardware description language. Algorithmic, architectural, and implementation aspects of arithmetic processing elements. Design of Complex Instruction Set (CISC), Reduced Instruction Set (RISC), and floating-point processors. Synthesis, simulation, and testing of processors with computer-aided design tools. Student in some sections may, on permission, fabricate VLSI chips.

EEGR745: Advanced Secure Embedded Systems - Three hours lecture: 3 credits
This course ties together the knowledge from previous classes in advanced hardware reverse engineering, advanced communication system, and advanced cryptography. The students will develop a more extensive system using the learning outcomes from these courses, and the students will evaluate the developed system in a real-world programming environment. This course is an actual engineering task in which the student must not only implement the algorithm code but also handle the interfaces between many different actors and hardware platforms.

EEGR 750: Trustworthy Machine Learning - Three hours lecture: 3 credits.
The course covers different topics in emerging research areas related to the broader study of security and privacy in machine learning. Students will learn about attacks against computer systems leveraging machine learning, as well as defense techniques to mitigate such attacks. The class is designed to help students explore new research directions and applications. Most of the course readings will come from both seminal and recent papers in the field. Design projects are an integral part of this course.

EEGR 755: Advanced Software Assurance - **Three hours lecture: 3 credits**.
This course covers the areas critical to software assurance: security requirements, risk analysis, software supply chain assurance, mission thread analysis and measurement. This course will train students to the advanced concepts and resources available for software security assurance across the acquisition and development lifecycles of software. Design projects are an integral part of this course.

EEGR765: Advanced Artificial Intelligence and Machine Learning - Three hours lecture: 3 credits.
This course presents advanced topics in Artificial Intelligence (AI). Topics will cover software agents, graph data search structures needed to create software agents, the conceptual differences between propositional logic, first-order logic, fuzzy logic, default logic, and statistical tools commonly used in AI, the basic symbol system, and the Turing machine.

EEGR 715: Advanced Topics in Communications - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 720: Advanced Topics in Signal Processing – Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 722: Advanced Topics in Image Processing - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 725: Advanced Topics in Control Theory - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 730: Special Topics in Microwave Engineering - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 732: Special Topics in Electromagnetics - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 740: Special Topics in Solid State and Optical Electronics - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 742: Special Topics in Microelectronics - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 760: Special Topics in Computer Engineering - Three Hours lecture: 3 Credits
This course will address selected advanced topics on this subject that are of interest to the students and instructor.

EEGR 780 - MSU/JHU Engineering Education Study - Three Hours lecture: 3 Credits
This course will facilitate educational exchange between students at Morgan State University and Johns Hopkins University.

EEGR 788: Seminar I - One Hour: 1 Credit
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.

EEGR 789: Seminar II - One Hour: 1 Credit
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.

EEGR 790: Independent Study - Three Hours: 3 Credits
The course of Independent Study is a program of research consisting of directed reading and/or laboratory work under the direction of a graduate faculty member. This course can be taken for 2 to 6 credits consistent with the proposed effort, and this course is repeatable up to a maximum of 6 credits.

EEGR 793: Master's Pre-Candidacy/Project Guidance - Three Hours: 3 Credits (Reports as 9)
This course conveys full-time status to a master's graduate student engaged in study prior to the achievement of master's candidacy. Students preparing for comprehensive examinations or for a thesis proposal defense enroll in this course. Additionally, students needing additional time to complete a Master's Project enroll in this course after initial enrollment in the appropriate Master's Project course. This course is a non-curricular course and cannot be used as a program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

EEGR 794: Scholarly Project - Three Hours: 3 Credits
This course provides the student with an opportunity to independently engage in analysis and design for an electrical engineering problem under the guidance of a faculty advisor. This course should be taken in the final semester.

EEGR 795: Project Report - Three Hours: 3 Credits
Project Report allows students to learn how to prepare and conduct a real project. This course emphasizes the continued analysis and the design of a specific electrical engineering problem under the guidance of a faculty advisor. The student will work on the approved project under the supervision of a faculty advisor and learn how to conduct and solve a real world problem. This course emphasizes the continued analysis and the design of a specific electrical engineering problem under the guidance of a faculty advisor, and culminates in a final report.

EEGR 797: Thesis Guidance - Three Hours: 3 Credits (Reports as 9)
This course enables a master's student to develop and execute an approved scholarly research agenda in consultation with the student's thesis chairperson and committee. Students register for this course continuously to maintain enrollment until the student has completed the thesis. This course is a non-curricular course and cannot be used as a program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

EEGR 799: Thesis Defense - Three Hours: 3 Credits (Reports as 9)
This course allows master's students the opportunity to defend their thesis for approval by the student's thesis chairperson and committee after the thesis has been completed. After gaining approval of the thesis chairperson and committee, the thesis is submitted to the School of Graduate Studies for final processing and approval. This course is a curricular course and is counted as 3 credit hours of the overall program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

EEGR 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

EEGR 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.

EEGR 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.

EEGR 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.

EEGR 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 dissertatio

EEGR 830 - Pre-Candidacy Research VI- 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.

EEGR 905 - Dissertation Research I-VI - 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.

EEGR 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.

EEGR 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.

EEGR 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.

EEGR 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.

EEGR 930 - Dissertation Research VI- 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.

EEGR 993: Pre-doctoral Candidacy - Three Hours: 3 Credits (reports as 9)
This course conveys full-time status to a doctoral student as a full-time student engaged in study prior to the achievement of doctoral candidacy. Students preparing for comprehensive examinations or preparing for a proposal defense enroll in this course. This course is a non-curricular course and cannot be used as a program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

EEGR 997: Dissertation Guidance - Three Hours: 3 Credits (Reports as 9)
This course enables a doctoral student to develop and execute an approved scholarly research agenda in consultation with the student's dissertation chairperson and committee. Students register for this course continuously to maintain enrollment until the student has completed the dissertation. This course is a non-curricular course and is not considered a program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

EEGR 998: Dissertation Defense - Three Hours: 3 Credits (Reports as 9)
This course allows doctoral students the opportunity to defend their doctoral dissertation for approval by the student's dissertation chairperson and committee after the dissertation has been completed. After gaining approval of the dissertation chairperson and committee, the dissertation is submitted to the School of Graduate Studies for final processing and approval. This course is a curricular course and is counted as 3 credit hours of the overall program credit requirement. The student registers for 3 credit hours and the registration reports the full-time status of 9 graduate credit hours.

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 Computer, Software or Electrical Systems 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's 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 ECE Department has Offices/Services to support Advertising, Recruiting, and Admissions. 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 IEEE 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 Electrical and Computer Engineering at Morgan State University has distinguished faculty with backgrounds and expertise in computer engineering, artificial intelligence, machine learning, software design, embedded systems, hardware/software assurance, cybersecurity, cryptography, control systems, and power electronics. Fourteen faculty within the ECE department are affiliated with the Program. All associate faculty are listed below.

First Name	Last Name	Appointment Type	Degree/Field	Academic Title/Rank	Status	Expertise
Tanvir	Arafin	Tenure Track	Ph.D./ECE	Assistant Professor	Full Time	Embedded Systems
Getachew	Befekadu	Tenure Track	Ph.D./ECE	Assistant Professor	Full Time	Control Systems, Computational Modeling
Cliston	Cole	Tenure Track	Ph.D./ECE	Assistant Professor	Full Time	Signal Processing & Network Security
Arlene	Cole-Rhodes	Tenured	Ph.D./EE	Professor	Full Time	Signal Processing for Wireless Communications & Remote Sensing
Mulugeta	Dugda	Lecturer	Ph.D./EE	Lecturer	Full Time	Digital Communication & Machine Learning
Duane	Harvey	Tenure-Track	D.Eng./ECE	Associate Professor	Full Time	Wireless Comm., Systems Arch. & High Freq. Electronic Systems
Kevin	Kornegay	Tenured	Ph.D./EECS	Professor	Full Time	Secure Embedded Systems
Deanna	Bailey	Lecturer	D.Eng./ECE	Lecturer	Full Time	Advanced Communication Systems
Jumoke	Ladeji-Osias	Tenured	Ph.D./EE	Professor	Full Time	Synthetic Vision Systems
Kofi	Nyarko	Tenured	D.Eng./ECE	Associate Professor	Full Time	Machine Learning, Computer Vision & Software Engineering
Onyema	Osuagwu	Tenure Track	Ph.D./ECE	Associate Professor	Full Time	Artificial Intelligence & Machine Learning
Michel	Kornegay	Tenured	Ph.D./ECE	Associate Professor	Full Time	Device Characterization & Modeling
Michael	Spencer	Tenured	Ph.D/EE	Professor	Full Time	Power Devices & Semiconductor Materials
Ketchiozo	Wandji	Tenure Track	Ph.D./ECE	Associate Professor	Full Time	Cybersecurity & Software Security
Gregory	Wilkins	Professor of Practice	Ph.D./ECE	Professor of Practice	Full Time	Computational Electromagnetics

I.2. Pedagogy Training for Faculty

I.2.a) 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.b) 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.c) 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. /M.S. program requires modest additional library resources - books and journals on computer architecture, embedded systems, computer security, cryptography, data science, data mining, data science tools, visualization, image processing, pattern recognition, machine learning, high-performance computing, etc.

J.1.3. Bookstore

Morgan State University's bookstore will sell textbooks, journals, 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./M.S. in Computer and Electrical Systems Engineering will be offered by the ECE Department. It is administered by the Electrical and Computer Engineering Department, Schaefer Engineering Building (SEB) Room 224, and housed in existing laboratories located throughout SEB.

K.1.2. Infrastructure Equipment

The Program will also leverage research infrastructure and equipment provided by the research labs and centers located in the Schaefer Engineering Building.

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 other laboratories that conduct research in artificial intelligence, cybersecurity, network security, power electronics, control systems, and hardware/software assurance.

K.1.4. Associated Research Centers & Labs

Advanced Research in Microwave/RF Measurement and Electronic Design

ARMMED is an active research lab that has capabilities to perform high-frequency device modeling and develop innovative component measurement techniques, design static and adaptable high-performance RF/microwave/mm-wave/sub-THz electronic circuits for communication systems. Our mission is to pursue new technologies, solve advanced problems and secure vulnerabilities in embedded systems for wireless communications that operate in the RF to sub-THz frequency spectrum.

Advanced Realization and Characterization of Architectures for DSP Engineering

Recent work in the ARCADE laboratory, through Federal and private Foundation-funded awards, includes embedded systems security and engineering education in the areas of experiment-centric pedagogical approaches to laboratory courses, improving science, engineering experiences for middle school students, and developing a national high school engineering curriculum.

Cybersecurity Assurance & Policy (CAP) Center

Morgan State University expands upon our emergence in cybersecurity assurance and policy research along with government agency, industry, and DoD partnerships to announce the formation of the internet-of-things (IoT), artificial intelligence/machine learning, privacy and security policy cohort. This is a collaboration between the Schools of Business & Management, Computer, Mathematical & Natural Sciences, and Engineering to enhance our leadership in this area. A total of eight faculty members who reside in their respective home departments will support Morgan State University's leadership in cybersecurity assurance and policy research.
The mission of the CAP center is to provide the electronics industry and intelligence community with knowledge, methodology, solutions, and skilled cybersecurity engineers to help prevent penetration and manipulation of our nation's cyber physical infrastructures. We apply invasive and noninvasive hardware and software reverse engineering techniques to assess physical layer cybersecurity vulnerabilities in embedded systems, specifically IoT devices. We also develop countermeasures to secure them against sensitive data extraction, disruption, diversion, and obfuscation.

Center for Reverse Engineering and Assured Microelectronics (CREAM) Lab

The primary mission of the CREAM Lab is to provide the intelligence community with knowledge, methodology, solutions, and skilled engineers to help mitigate penetration and manipulation of our cyber-physical infrastructure. CREAM conducts research using novel non-invasive reverse engineering techniques to evaluate the assurance of embedded systems and develops countermeasures and assurance solutions to secure them against sensitive data extraction, system disruption, and diversion. The center consists of several laboratories that are housed in several rooms located in the Clarence Mitchell School of Engineering building at Morgan State University. One laboratory consists of two adjacent 40 ft. x 50 ft. rooms and includes the following hardware and software.

Data Engineering and Predictive Analytics Research Lab

DEPA develops tools, technology and techniques that provide insight into complex data and concepts by performing research in computational engineering modeling, simulation, and visualization. Specific capabilities include engineering simulation, modeling and controls, complex algorithm development, complex network visualization, portable computing development, advanced display technologies, UAS and avionic control and software systems development.

Signal and Image Communications Research Lab

In this lab, we develop algorithms for signal processing applications ranging from a multi-resolution image registration technique for remote sensor applications, to data analysis using information from digital image and video data processing, to blind equalization for wireless MIMO communications systems. Current work involves the investigation of adaptive beamforming techniques to enable millimeter wave multi-user MIMO wireless communications, and this has involved the use of a previously developed blind channel estimator. The work in this lab is directed by Dr. Arlene Cole- Rhodes and her research has been sponsored over the years by NSF, NASA, Army Research Labs and the Department of Defense.

Wireless Networks and Security

Primary focus on Integrated Network Enhanced Telemetry regarding Radio link protocol and Mixed Network Modeling. Since its formation, students and faculty in WiNetS lab have offered credible solutions in several Wireless Communication-related research problems funded by federal agencies such as Test Resource Management Center (TRMC) Test and Evaluation, Science & Technology (T&E/S&T) and U.S. Army. Cyber security is an exciting part of the WiNetS lab. As cyber attacks continue to increase in number and complexity, there has to be a greater effort from the cyber security industry to detect and prevent these attacks. The main goal of the cyber security team in the WiNetS lab is to contribute to stopping cyber attacks by researching and analyzing attacks and figuring how to prevent them.

K.1.5. Required Computer Resources

The proposed Ph.D./M.S. in Computer and Electrical Systems Engineering requires additional computer and electronics hardware such as desktops, tablets, smartphones, etc. In addition, computer-software resources, basic electronics components, and measurement equipment are needed.

K.2. Program Assurance in Distance Education

Morgan uses Google's Gmail for its email system and Canvas[26] is the learning management system. The Program will use both traditional classrooms and/or Canvas for online course distribution.

L. Adequacy of Financial Resources with Documentation

L.1. Resources and Narrative Rationale

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)	237,983	265,734	299,401	379,505	384,837
a. Number of F/T Students	15	18	20	25	25
b. Annual Tuition/Fee Rate	13,599	13,803	14,010	14,220	14,433
c. Total F/T Revenue (a xb)	203,985	248,454	280,201	355,505	360,837
d. Number of P/T Students	8	9	10	13	13
e. Credit Hour Rate	756	320	320	320	320
f. Annual Credit Hours	6	6	6	6	6
g. Total P/T Revenue (d x e x f)	33,998	17,280	19,200	24,000	24,000
3. Grants, Contracts & Other External Sources	0	0	0	0	0
4. Other Sources (Lab Fees)	0	0	0	0	0
TOTAL (Add 1 – 4)	237,983	265,734	299,401	379,505	384,837

1. Tuition/Fees Revenue $ 1,567,458

The graduate tuition and fees for both full-time and part-time Ph.D. students include a 3% increase every year for five years.

F/T tuition is calculated with # students X cost per credit X 18 credits annually.

P/T tuition is calculated with # students X cost per credit X 6 credits annually (avg. annual credits)

L.2. Program Expenditures and Narrative Rationale

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	98,100	100,553	103,066	105,643	108,284
a. # FTE	1	1	1	1	1
b. Total Salary	90,000	92,250	94,556	96,920	99,343
c. Total Benefits	8,100	8,303	8,510	8,723	8,941
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)	34,880	35,752	36,646	37,562	38,501
a. # FTE					
b. Total Salary	32,000	32,800	33,620	34,461	35,322
c. Total Benefits	2,880	2,952	3,026	3,101	3,179
4. Equipment	0	0	0	0	0
5. Library	$ 40,000	$ 41,200	$ 42,436	$ 43,709	$ 45,020
6. New or Renovated Space					
7. Other Expenses +	0	0	0	0	0
TOTAL (Add 1 – 7)	**132,980**	**136,305**	**139,712**	**143,205**	**146,785**

1. Faculty
One (1) additional faculty provide instruction and research guidance for existing and future students. The average 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%.

3. Support Staff
One (1) support staff member will assist the Graduate Coordinator and provide programmatic support related to the proposed new program.

4. Library
IEEE subscription

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 the Department of Electrical and Computer 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 on their performance in the 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.

Some purposes 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 ECE Department Chair and Graduate Coordinator.

M.1. Procedures for Evaluating Courses, Faculty and Student Learning Outcomes

At the end of each semester, the ECE 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 Program, students will have the knowledge and skills needed to successfully:

- Use current hardware, software, electrical systems, tools and methodologies to address engineering grand challenge problems
- Understand and follow trends in computer hardware/software engineering, artificial intelligence, and electrical systems engineering
- 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./M.S. in Computer and Electrical Systems Engineering is designed to recruit, retain graduates 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 degrees 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 appropriately 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; it establishes the 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./M.S. in Computer and Electrical Systems 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 is Maryland's Preeminent Public Urban Research University. Morgan has also recently been elevated from a Carnegie Doctoral Research University (R3) classification to a High Research Activity University (R2).

Morgan has had Middle States Association of Colleges and Schools, Commission on Higher Education Accreditation since 01/01/1925. Morgan is comprised of two colleges and ten 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
- College of Interdisciplinary and Continuing Studies

Morgan has academic programs at both undergraduate and graduate levels:

- 45 bachelor's degree Programs
- 10 post-baccalaureate's certificates
- 37 master's degree Programs
- 16 doctoral degree Programs

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 Degree Programs, a Masters 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 Transportation and Urban Infrastructure Studies
- Post-Baccalaureate Certificates in Cybersecurity and Transportation
- Masters of Engineering (All Departments)
- Doctorate of Engineering (All Departments)
- Ph.D. in Transportation

Appendix III. Department of Electrical and Computer Engineering

The Department of Electrical and Computer Engineering provides its students the opportunity to apply mathematical and physical concepts to engineering problems early in the curriculum, through laboratory and design experiences. The Department has been following the philosophy of design across the curriculum for some time. In addition to the strong design experience integrated throughout the required courses, the electives offer students the opportunity to enhance their skills with additional open-ended problem-solving. These problems are broad-based, incorporating knowledge from specialty areas of communications systems, signal processing, microwave systems, solid-state electronics, controls and automation, power, computer engineering, and cybersecurity. Computer engineering and cybersecurity are special components of the electrical engineering (EE) program, where the Department offers a concentration. This expands and rounds out the program by providing the necessary tools to meet the demands of the information age. Most of the faculty are distinguished and experienced professionals with a strong commitment to teaching and research excellence.

The ECE Department has 21 faculty members: 5 tenured full professors, 7 tenured/tenure-track associate professors, 2 tenure-track assistant professors, 7 full/part-time lecturers, and 1 professor of practice.

- Full Professors
  - Dr. Arlene Cole-Rhodes (arlene.colerhodes@morgan.edu)
  - Dr. Kevin T. Kornegay (kevin.kornegay@morgan.edu)
  - Dr. Kemi Ladeji-Osias (jumoke.ladeji-osias@morgan.edu)
  - Dr. Craig J. Scott (craig.scott@morgan.edu)
  - Dr. Michael G. Spencer (michael.spencer@morgan.edu)
  - Dr. Carl White (carl.white@morgan.edu)
- Associate Professors
  - Dr. Yacob Astatke (yacob.astatke@morgan.edu)
  - Dr. Duane Harvey (duane.harvey@morgan.edu)
  - Dr. Michel Kornegay (michel.kornegay@morgan.edu)
  - Dr. Onyema Osuagwu (onyema.osuagwu@morgan.edu)
  - Dr. Kofi Nyarko (kofi.nyarko@morgan.edu)
  - Dr. Ketchiozo Wandji (ketchiozo.wandji@morgan.edu)
- Assistant Professors
  - Dr. Md Tanvir Arafin (mdtanvir.arafin@morgan.edu)
  - Dr. Getachew Befekadu (getachew.befekadu@morgan.edu)
  - Dr. Cliston Cole (cliston.cole@morgan.edu)
- Professor of Practice
  - Dr. Gregory M.Wilkins (gregory.wilkins@morgan.edu)
- Full/Part-Time Lecturers
  - Dr. Deanna Bailey (deanna.bailey@morgan.edu)
  - Dr. Mulugeta Dugda (mulugeta.dugda@morgan.edu)
  - Dr. Petronella A. James-Okeke (petronella.james@morgan.edu)
  - Dr. Richard Dean (richard.dean@morgan.edu)
  - Dr. Hailu Kassa (hailu.kassa@morgan.edu)
  - Ms. LaDawn Partlow (ladawn.biddle@morgan.edu)

Appendix IV. Morgan State University Mission

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

Growing the Future

Five broad goals represent the foundation of this strategic plan. Over the next ten years, these goals will guide Programs, services, and budgets that are designed to grow Morgan's future by implementing the strategic initiatives for each goal. The goals include:

Goal 1: Enhancing Student Success Morgan will create an educational environment that enhances student success by hiring and retaining well-qualified, experienced, and dedicated faculty and 5 staff, offering challenging, internationally relevant academic curricula, and welcoming and supporting a diverse and inclusive campus community.

Goal 2: Enhancing Morgan's Status as a Doctoral Research University Morgan will enhance its status as a Doctoral Research University through its success in securing grants and contracts and its faculty's achievements in basic and applied research, professional expression, artistic creation, and creative inquiry. Additionally, initiatives will be designed to enhance doctoral achievement in the science, technology, engineering, and mathematical (STEM) and non-STEM disciplines for underrepresented students of color.

Goal 3: Improving and Sustaining Morgan's Infrastructure and Operational Processes Morgan will enhance its infrastructure and processes by improving the efficiency and efficacy of its operating procedures, by focusing on the environmental sustainability of its facilities, and by meeting the technological customer service needs of its students, faculty, staff and community.

Goal 4: Growing Morgan's Resources Morgan will expand its human capital as well as its financial resources by investing in the professional development of faculty, staff, and students, seeking greater financial support from alumni, the State and federal governments, private and philanthropic sources, and establishing collaborative relationships with private and public entities. The issue of indirect costs associated with contracts and grants will be revisited.

Goal 5: Engaging with the Community Morgan will engage with community residents and officials in the use of knowledge derived from faculty and student research, the sharing of mutually beneficial resources, and the appropriate and timely dispatch of University experts and professionals to collaborate in addressing community concerns.

Appendix VI. Priorities and Enhanced Goals for 2019-2023

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 R2 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. Growing the Future, Leading the World: Strategic Plan for Morgan State University for 2011–2021

Approved by the Board of Regents on 8/2/11. A complete copy of the document can be found at the link below:https://issuu.com/Morganstateu/docs/strategicplan2011-21_final?e=2119971/60089621