MORGAN STATE UNIVERSITY
GROWING THE FUTURE • LEADING THE WORLD

Provost and Senior Vice President for Academic Affairs

August 28, 2020

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

Dear Dr. Fielder,

Please find attached a new academic program proposal for review and approval. The Board of Regents of Morgan State University at its August 4, 2020 meeting approved the following program.

"PhD in Secure Embedded Systems"

This proposal is submitted with full confidence in Morgan's capacity to offer this program as presented. Morgan State University is financially able to support this proposed program. Please keep us informed as to the review process.

If you need any additional information, please do not hesitate to contact me at lesia.young@morgan.edu or (443)885-3350.

Sincerely,

Lesia Crumpton-Young

Dr. Lesia Crumpton-Young
Provost and Senior Vice President for Academic Affairs, Morgan State University

cc: Dr. David Wilson, President, Morgan State University
Dr. Farzad Moazzami, Interim Assistant Vice President for Academic Affairs, MSU
Dr. Oscar Barton, Dean, School of Engineering, MSU
Dr. Kevin Kornegay, Director of the Cybersecurity Assurance & Policy Center, MSU
Dr. Emily Dow, Assistant Secretary for Academic Affairs, Maryland Higher Education Commission

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

Institution Submitting Proposal	Morgan State University

Each action below requires a separate proposal and cover sheet.

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

Payment Submitted: (●) Yes ( ) No
Payment Type: (●) R*STARS ( ) Check
Payment Amount: $850
Date Submitted: 8/26/2020

Department Proposing Program	Electrical and Computer Engineering Department - School of Engineering	
Degree Level and Degree Type	Ph.D.	
Title of Proposed Program	Secure Embedded Systems	
Total Number of Credits	60	
Suggested Codes	HEGIS: 90900.00	CIP: 14.4701
Program Modality	(●) On-campus	( ) Distance Education (*fully online*)
Program Resources	(●) Using Existing Resources	( ) Requiring New Resources
Projected Implementation Date	( ) Fall (●) Spring ( ) Summer	Year: 2021
Provide Link to Most Recent Academic Catalog	URL: http://catalog.morgan.edu/	
Preferred Contact for this Proposal	Name: Dr. Farzad Moazzami	
	Title: Interim Assistant Vice President for Academic Affairs	
	Phone: (443) 885-3350	
	Email: farzad.moazzami@morgan.edu	
President/Chief Executive	Type Name: Dr. Lesia Crumpton-Young	
	Signature: Lesia Crumpton-Young	Date: 08/28/2020
	Date of Approval/Endorsement by Governing Board:	

Revised 3/2019

Ph.D. in Secure Embedded Systems

Contents

A. Centrality to Institutional Mission and Planning Priorities

Morgan State University[1] (Morgan) proposes a new academic graduate degree program, Doctor of Philosophy in Secure Embedded Systems (hereafter the "Ph.D. in Secure Embedded Systems" or the "Program"). The Department of Electrical and Computer Engineering[2] proposes the Program in collaboration with the School of Business and Management (Information Sciences & Systems) and the School of Computer, Mathematical, and Natural Sciences (Computer Science).

A.1. Program Description

The Internet of Things (IoT) is an excellent opportunity for the progression of embedded systems. IoT mobile devices like smartphones, tablets, and wearables are already ubiquitous. As the IoT market is expanding, we expect that non-mobile IoT systems will outnumber the current IoT-enabled mobile devices that we know. With each passing day, embedded systems are getting smaller and smarter, enabling us to get more things done than before. As we embed more functionality in smaller device footprints, there is an upsurge in the security concerns as well. To address the security concerns, we present the Ph.D. in Secure Embedded Systems.

The Ph.D. program in Secure Embedded Systems targets highly motivated students. They 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 Secure Embedded Systems 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.

Core Courses Elective Courses Research Courses	12 credits 12 credit 18 credits
Dissertation Research	18 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).

Core Courses *or* Elective Courses *or* Research Courses	18 credits
Dissertation Research	18 credits
Total	**36 credits**

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

Students with a master's degree in the approved areas listed in Table C will be required to take a minimum of 18 credits of core, elective and/or research courses and 18 credits of Dissertation Research. Students who only have a bachelor's degree or who do not have a master's degree of an approved degree type listed in Table C will be required to take a minimum of 4 core courses totaling 12 credits, and a minimum of 18 credits of Dissertation research.

[1] Appendix I [2] Appendix III [3] Appendix II

Masters in Electrical Engineering, Advanced Computing, Computer Science, or Computer Engineering
Masters in Software Engineering
Masters in Information Systems
Approved Masters Degree in Related Areas

Table C: List of approved master's degree types for direct admission to the Ph.D. in Secure Embedded Systems Program. *

Students in the bachelors to Ph.D. track will receive an *en passant*, or "along-the-way," master's degree, **Master of Science in Secure Embedded Systems**, after completing 30 credits in the Ph.D. program. These 30 credits must include 12 credits of Core courses, 12 credits Elective courses, and 6 credits of Research courses.

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 Ph.D. in Secure Embedded Systems supports three of Morgan's Strategic Plan goals:

Goal 1: Enhancing Student Success The Program supports Morgan's goal in leading the State of Maryland in graduating underrepresented minority students in STEM disciplines by offering challenging, internationally relevant academic curricula. The establishment of the Ph.D. in Secure Embedded Systems enhances Morgan's instructional capacity to train professionals to serve the City of Baltimore, the State of Maryland, the region and nation by attracting underrepresented students to this unique program. This program will also contribute to the Strategic Initiatives of the Cybersecurity Assurance & Policy (CAP) Center[5] to expand academic program offerings, including new and online degree programs and up-to-date curricula, as well as, enhance research and scholarly activities and capabilities.

Goal 2: Enhancing Morgan's Status as a Doctoral Research University As a Carnegie high research activity (R2) university, the Ph.D. in Secured Embedded Systems will have a profound impact on maintaining and growing our research stature by increasing Ph.D. production, number of publications, and sponsored research funding.

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 such as student mentoring, guest lecturing, internships, etc.

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. To date, five out of the eight total tenure-track faculty for this Program have been hired over the past two years, including four in Electrical and Computer Engineering (ECE) and one in Computer Science (CS). Faculty searches are underway to hire the remaining faculty, one each in ECE, CS, Information Systems. Also, staff, including program manager, IT manager, and administrative assistant, have been hired to support the Program.

The Department of Electrical and Computer Engineering has faculty with extensive experience in cybersecurity, embedded systems, artificial intelligence, and machine learning, reverse engineering, and hardware/software Assurance.

*Program reserves the right to accept other program types as part of the approved list pending thorough content review and analysis.

[4] Appendix V [5] http://www.iotcream.com

The Department of Information Systems in the School of Business and the Department of Computer Science offers cybersecurity-related courses, and both have faculty with complementary expertise in cybersecurity.

Our faculty have established research collaborations and strategic partnerships with the National Science Foundation (NSF)[6], National Institute of Standards and Technology (NIST)[7], the MITRE Corporation, NASA Jet Propulsion Laboratory, National Security Agency (NSA)[8], Praxis Engineering, MIT Lincoln Laboratory[9], Dartmouth College[10], Johns Hopkins University [11], University of Delaware[12], and the University of Maryland at College Park. Our graduate students in the ECE Department exemplify scholarship as recipients of prestigious national fellowships such as the National GEM Consortium [13].

A.4. Morgan Commitment

The Ph.D. in Secure Embedded Systems has received full support from Morgan's President, Dr. David Wilson, as well as Provost and Senior Vice President for Academic Affairs, Dr. Lesia Crumpton-Young. President Wilson, during his 2020 State of the Union Address to Morgan faculty, students, and staff, announced that cybersecurity would be the catalyst that would propel Morgan to the Carnegie research classification of highest research activity. With an annual two million dollar State appropriation, Morgan has established the CAP Center. The CAP Center is a university-wide research center 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. CAP consists of faculty from the Schools of Engineering (SoE), Computer, Mathematics, and Natural Sciences (CMNS), and Business (SoB). CAP has had a positive impact at MSU, including increased student enrollment, grantsmanship, new strategic partnerships, and new program development.

Morgan will support the Ph.D. in the Secure Embedded Systems Program with eight new tenure-track faculty members. Laboratory facilities with furniture, phones, Internet access, computers, printers, smart and standard boards, classrooms, an instructional computer lab with 30 workstations, a printer, intelligent and standard whiteboards, study rooms, library resources, and faculty/staff/student offices. The University is committed to establishing the Ph.D. in Secure Embedded System Program with full financial and institutional support.

In alignment with Morgan's mission statement[14] and it's planning priorities[15,16], this new Ph.D. program 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. To realize the institutional mission and strategic planning goals, Morgan has focused on developing unique high demand degree Programs to offer both in traditional classroom face-to-face settings as well as online.

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[6] https://nsf.gov/awardsearch/showAward?AWD_ID=1458930&HistoricalAwards=false
[7] https://www.nccoe.nist.gov/events/mitigating-iot-based-ddos-industry-day
[8] https://news.morgan.edu/morgan-faculty-students-participate-in-nsa-cyber-and-telecomm-research-program/
[9] https://drive.google.com/file/d/1HYdKzF7_g0IsMUE4KxZV1NyefH52pjaW/view?usp=sharing
[10] https://thaw.org/?s=morgan&submit=Search
[11] https://engineering.jhu.edu/news/2018/08/10/jhu-nist-research-consortium/#.XnfEk9NKiKU
[12] https://drive.google.com/file/d/1gkR5_Ok2feUSzhZ8hRSzi8ckbOcM4hHW/view?usp=sharing
[13] http://www.gemfellowship.org/about-gem/overview/
[14] Appendix IV
[15] Appendix VI
[16] Appendix VII

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 Postsecondary Education, of 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 is Maryland's Preeminent Public Urban Research University, and innovation is one of the institution's core values.

The Program, in terms of present and future needs of the region and State, follows.

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

Research methods in the areas of science, engineering, and business have changed significantly over the past few decades. Embedded system professionals are in high demand across all areas of STEM. For today's graduates, it is one of the most valuable career skills. Similar to the way Silicon Valley benefits from tech giants Google, Facebook, and Apple, the State of Maryland can benefit from their proximity to the metropolitan DC area, including Northern Virginia, where embedded systems giant Amazon will bring thousands of new jobs in HQ2.

Large Maryland-area employers seeking expertise in embedded systems design include:

- Federal agencies: NASA, NSA, NSF, NIH, NIST, FDA, EPA, DHS, USDA;
- Military: RDECOM, CECOM, Naval Air Systems Command, ARL, AFRL, NRL;
- FFRDC: APL, NCCoE, JPL, MITRE;
- Industry: Google, Apple, Amazon, Intel, NXP, CISCO, Qualcomm;

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.

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

The Baltimore/Washington/DC area has a diverse population with a wide variety of job opportunities in areas such as cybersecurity, intelligence, defense, and healthcare for students who have acquired skills, training, and competency.

B.1.c) Need to strengthen and expand the capacity of HBCU's in Embedded Systems

Maryland has a massive workforce shortage in embedded systems with countless opportunities, as described in the following Section C. The State of Maryland is the epicenter of intelligence and defense communities 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. Morgan is also well-positioned to support this Community, given its proximity.

B.2. Compliance with State Postsecondary Education Plan

The Ph.D. in Secure Embedded Systems 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 robust 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 no small measure, an effort by the University to fulfill its access mission by providing agile degree programs on campus and online to expand educational opportunities for traditional and non-traditional students. As noted in the State Plan, non-traditional students comprise the majority of post-secondary students who delay initial enrollment or are returning, part-time, are financially independent of parents, have families to support, or work full-time. These students have needs and expectations that are often quite different from those of the traditional high school-to-college student.

  The Ph.D. in Secure Embedded Systems is consistent with Morgan's access mission in that by offering the degree on campus and online to more students, mainly non-traditional students. They will have the opportunity to earn a degree in a unique, high demand STEM-based program. As members of underrepresented in STEM disciplines, offering the Ph.D. in Secure Embedded Systems at Morgan serves to improve student access in this discipline and career pathway.

- **Success**

  Morgan has several well-established initiatives to increase the educational success of underserved populations. A key aspect of student success at Morgan is the 50 by 25 Campaign to raise the six-year graduation rate to 50% by 2025. The President reported to the General Assembly:

  > Beginning with the entering class of 2010, the University has significantly increased its freshman and sophomore retention rates. Second-year retention rates are above 70% for the past nine years. Third-year retention rates are at 60%. Fourth-year retention rates have risen to 56%. Our six-year graduation rates have increased from 31% for the fall 2009 cohort to 43% for the fall 2013 cohort.

  In summary, the Ph.D. in the Secure Embedded Systems degree integrates with 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 undergraduate and graduate degrees in most of the STEM disciplines.

- **Innovation**

  In March (2019), Morgan celebrated its 6th Annual' Innovation Day' in Annapolis, Md. at the Miller Senate Office Building. Morgan Innovation Day, which serves in part as an annual progress report, the goal of taking the lead in innovation and providing a pipeline to new technologies is consistent with our historic mission of preparing a diverse student body to help the world meet tomorrow's challenges. The Ph.D. program in secure embedded systems enhances Morgan's tradition of providing unique, high demand, and innovative academic programs.

  No higher education institution in Maryland offers a Ph.D. program in secure embedded systems. Collaborating with academic, industry, and government stakeholders, the Ph.D. program in secure embedded systems is an innovative degree program designed to provide maximum flexibility to graduate students, working professionals as well as non-traditional students to acquire instruction, skills, and competencies in a leading-edge career pathway essential to meet the workforce demand in the State and the nation.

In summary, the proposed Ph.D. in the Secure Embedded Systems program is unique in the DC, Maryland, Virginia (DMV) region, and does not duplicate any other Ph.D. degrees offered by any other university in Maryland.

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

Describe potential industry or industries, employment opportunities, and expected level of entry (ex: mid-level management) for graduates of the proposed program. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program. Discuss and provide evidence of market surveys that provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next five years. Provide data showing the current and projected supply of prospective graduates.

C.1. Embedded Systems Industry

An embedded system is a combination of software and hardware which together facilitate the accurate functioning of a target device. The significant characteristics of an embedded system are speed, power, size, accuracy, reliability, and adaptability. Embedded systems are application-specific, special-purpose systems, and they are designed typically for meeting real-time constraints. These systems appear across a diverse range of application areas, which include automotive, telecommunication, healthcare, industrial, consumer electronics, as well as military and aerospace, among others. The global embedded system market comprises both hardware and software, including processor IP, microcontrollers and microprocessors, digital signal processors, application-specific integrated circuits, field processing gate arrays, embedded boards, operating systems, software development and testing tools, middleware, open-source software, and tools.

Embedded hardware covers over 93% of the market share in 2015, and projects to dominate the market over the estimated period. These products include microcontrollers, digital signal processors (DSP), microprocessors, and others. Typically, embedded software consists of a middleware tool and an operating system (OS). Embedded systems have real-time constraints for use in a variety of safety-critical purposes. This sector is likely to rise at a Compound Annual Growth Rate (CAGR) of 6.36% from 2016 to 2021.

Automotive applications covered over 24% of the overall market in 2015 and expect to remain the most significant sector over the forecast period. In the automotive industry, embedded systems provide safety, infotainment, and engine control, among others. Growing demand for vehicles outfitted with car-to-road communication facilities and efficient navigation is estimated to drive the market. Furthermore, shifting focus towards hybrid electric vehicles (HEV) and electric vehicles (EV) to control emission is estimated to fuel embedded system market growth. Healthcare anticipates being the fastest rising application, at a CAGR of 8.35% from 2016 to 2021. Handheld and Portable medical equipment and devices such as vital signs monitoring systems make wide use of embedded systems. Consumer electronics, including HVAC (heating, ventilation, and air conditioning), microwave ovens, and mobile phones, use embedded software and hardware is projected to nurture the market over the next five years. Industrial applications include infrastructure, energy, and process control, among others. Data feedback and acquisition control systems for automation provide positive avenues to market growth for industrial applications.

Key hardware components include microcontrollers, DSPs and microprocessors, etc. Key market players include NXP (Freescale Semiconductor), Renesas Electronics, Intel Corporation, Xilinx, Altera, Infineon Technologies, Microchip, Fujitsu Limited, STMicroelectronics, Atmel, and Texas Instruments, Inc. among others. Also expected to fuel much more growth is an overarching megatrend referred to as the Internet of Things (IoT), which involves connecting more embedded systems to the internet, enabling countless human-to-machine and machine-to-machine applications. Fueled mostly by new internet protocols and wireless technology convergence, industry-wide estimates of 20 to 30 billion connected devices by 2020 are common among significant technology research companies. Of course, this trend ushers in greater hardware and software design challenges of effectively managing and securing connected devices, as well as capturing and harnessing the vast amounts of data the devices produce around their associated services.

The embedded system industry is moderately competitive, with the top ten vendors accounting for about 40% of the industry share. Renesas Electronics is the global largest vendor accounting for 7.66% of the industry share in 2015 and offers a wide range of components, which in turn intensifies the dependency of OEMs, while the embedded system's revenue of this company is decreasing year by year. In 2016, with the acquisition of a leading embedded solutions provider Intersil, Renesas Electronics' revenue shows an upward trend. Other key players include ARM Limited, Advantech, Kontron, and Analog

Devices, among others.

The worldwide market for Embedded Systems expects to grow at a CAGR of roughly 5.6% over the next five years, will reach $95400 million in 2024, from $68900 million in 2019, according to a new Global Info Research study[17].

An embedded systems engineer is a relatively new job classification that merges electrical engineering and computer science. These computer engineers work on hardware and software designs for electronic medical equipment, industrial and military control systems, mobile communications devices, appliances, and remote controls. The embedded systems industry offers potential opportunities and capabilities.

The ubiquity of devices with built-in microprocessors means businesses everywhere are hiring engineers who can work on embedded systems. Jobs for software developers will keep growing in the state of Washington state by 11% over the next ten years.

In Maryland, positions for software developers with embedded skills have more than tripled since 2016, according to EMSI [18] (a leader in mobile health data). And, based on a recent search of Indeed [19], it's not just major tech firms like Amazon and Google that are hiring, but newer companies like Sonos, a smart speaker company, and Zonar Systems, an intelligent transportation fleet company.

C.2. Employment Opportunities in Embedded Systems

Engineers with versatility in essential embedded technologies, markets, and trends are highly sought-after by companies that want to capitalize on the ever-expanding Internet of Things.

C.3. Salaries of Embedded Systems Professionals

PayScale[20] reported in 2019 that the median annual salary for an embedded systems engineer was $78,389. Specific wage data for embedded systems engineers are not available from the U.S. Bureau of Labor Statistics (BLS)[21]. Still, a review of information for electrical engineers and systems software developers can provide an idea of the salary an engineer in this field could expect. 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.

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

Figure 1: Average salaries of embedded systems engineers.

The average Embedded Systems Engineer salary in the USA is $105,000 per year or $53.85 per hour. Entry-level positions start at $38,805 per year, while most experienced engineers make up to $178,500 per year. As shown in Figure 1, the average salary of embedded system engineers in the State of Maryland is $105,000, whereas national salaries according to degree level are shown in Figure 2, respectively.

Expected entry-level positions for graduates of the Program include systems engineer, embedded software engineer, embedded hardware engineer, hardware security, digital forensics, as well as, careers in intelligence (e.g., NSA), DoD (e.g., Army Research Laboratory), academia, and industry (e.g., Google, Amazon, etc.).

C.4. Current and Projected Supply of Prospective Graduates

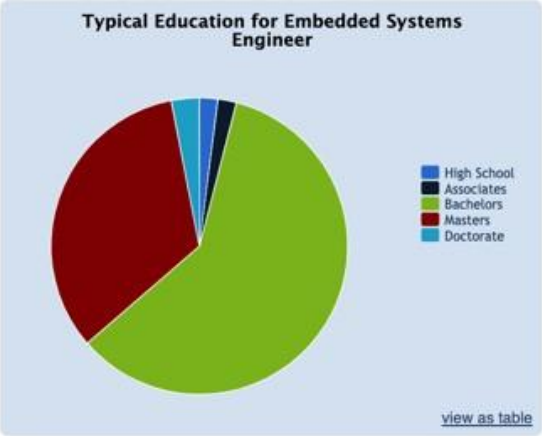
Congressional Research Service (CRS) analysis of Bureau of Labor Statistics [22] employment projections indicate that the science and engineering workforce will grow from 7.3 million to 8.2 million jobs between 2016 and 2026, an increase of 853,600 (11.7%) jobs over the ten years (1.1% CAGR). This growth rate is higher than the growth rate projected for all occupations (0.7% CAGR) during this period.

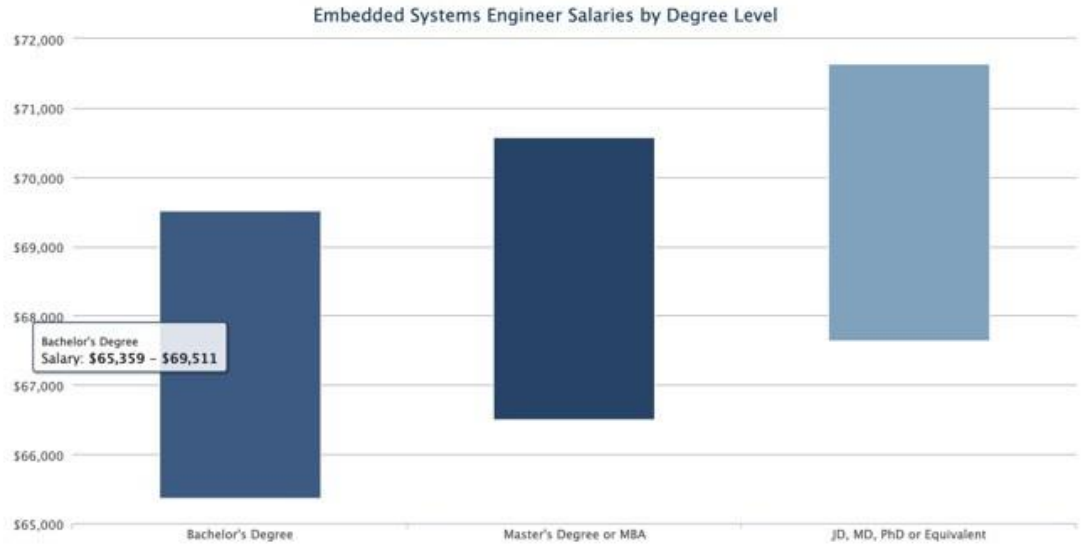
Figures 3 and 4 show the science and engineering occupations with the most projected job openings due to growth, labor force exits, and occupational transfers, respectively. The vast majority of the projected jobs are computer occupations, where embedded systems reside.

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

Salaries for Embedded Systems Engineer with a JD, MD, PhD or Equivalent

According to our 100% employer reported salary sources the median salary for a **Embedded Systems Engineer** with a **JD, MD, PhD or Equivalent** is **$67,632 - $71,633**. Please try our salary wizard to explore how other factors like location, Years of experience and number of direct reports can impact your base pay and bonus.





Embedded Systems Engineer with the following degree	Will likely fall in this salary range
Bachelor's Degree	$65,359 - $69,511
Master's Degree or MBA	$66,495 - $70,572
JD, MD, PhD or Equivalent	$67,632 - $71,633

Figure 2: Salaries for embedded systems engineers at the BS, MS, and Ph.D. levels.

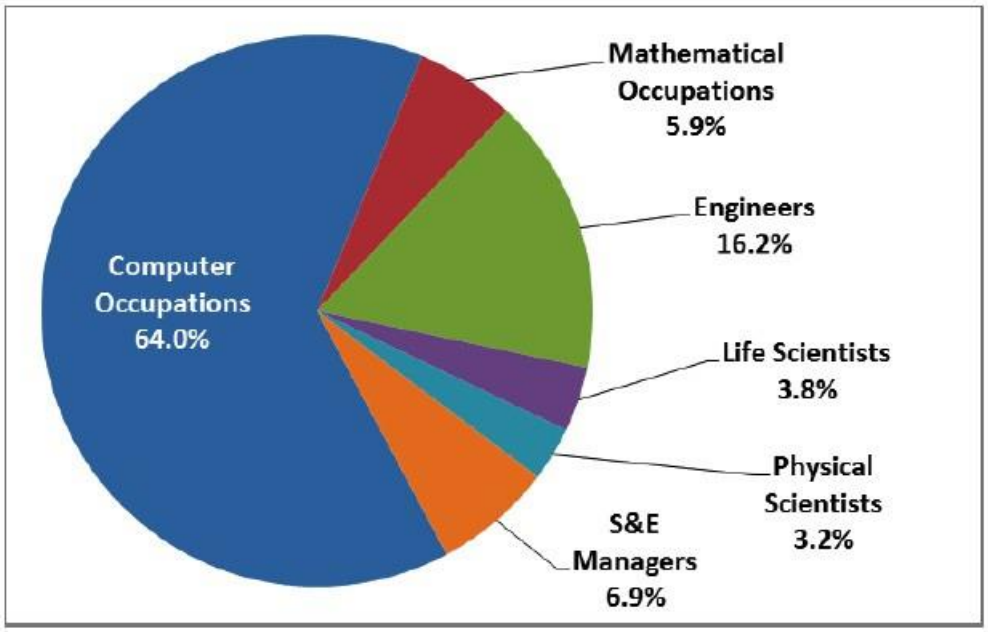


Figure 3: CLS analysis of Employment Projections, 2016-2026, Bureau of Labor Statistics, U.S. Department of Labor.

Rank	S&E Occupation	Projected Average Annual Job Openings[a]
1	Software developers, applications	85,500
2	Computer user support specialists	55,400
3	Computer systems analysts	44,800
4	Software developers, systems software	32,700
5	Computer and information systems managers	32,500
6	Civil engineers	27,000
7	Operations research analysts	25,900
8	Computer occupations, all other	22,300
9	Mechanical engineers	21,200
10	Industrial engineers	19,700

Figure 4: S&E Occupations with the Most Projected Job Openings Due to Growth Labor Force Exits, and Occupational Transfers from 2016-2026.

D. Reasonableness of Program Duplication

D.1. Similar Programs

According to our findings, there are no reasonably similar Ph.D. programs in the State of Maryland. However, the program that comes closest to our list is the Professional Master's degree in Embedded Systems and the Internet of Things at the University of Colorado at Boulder[23].

D.2. Justification for Proposed Program

There is no Ph.D. in the Secure Embedded Systems program in the State of Maryland, and there is a great need for professionals in this space as supported by the data provided in the previous sections.

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

To date, there are no equivalent programs at any of the State's HBIs, including Bowie State University, Coppin State University, and the University of Maryland Eastern Shore (UMES). The Ph.D. program in secure embedded systems will not have any negative impact on the State's HBIs. Furthermore, this program will enhance Morgan's reputation across the country since there is a need nationwide for such a program. Indeed, this program will be in high-demand and benefit Morgan State University substantially.

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

Morgan is the largest and most comprehensive of the State's four HBIs. In 2017, Morgan was designated by the General assembly as Maryland's Preeminent Public Urban Research University. Morgan was also elevated from a Carnegie research classification to a high-research kind 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. program in Secure Embedded Systems 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. Program Overview

G.1.1. Program Establishment

Dr. David Wilson, President of Morgan State University, and Provost Lesia Crompton-Young provided the impetus for the establishment of the Program, and Dr. Oscar Barton, Jr., Dean of the Clarence M. Mitchell, Jr. The School of Engineering is enthusiastically supportive. The Program builds upon the undergraduate courses offered by our NSA/DHS Center for Academic Excellence in Cyber Defense Education. It will provide the academic foundation for the graduate research conducted in the CAP Center. The Department of Electrical and Computer Engineering will offer the Program.

G.1.2. Program Oversight

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

[23] https://www.colorado.edu/ecee/embedded-systems

G.2. Educational Objectives and Learning Outcomes

G.2.1. Program Objectives

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

G.2.2. Expected Student Learning Outcomes

Upon completion of the Program, students will have gained a broad technical, and interdisciplinary background enhances their ability to identify and tackle critical cybersecurity problems related to embedded system hardware and software. Specifically, upon completing the Program, students will be expected to:

1. Demonstrate a breadth of knowledge in advanced cybersecurity, cryptography, networking, and reverse engineering; and exhibit deep expertise in any one or combination of the core breadth areas, such as lightweight cryptography for embedded systems, side-channel analysis, digital forensics;
2. Apply mathematics, systems theory, principles of engineering, planning/or management in solving complex cybersecurity problems;
3. Design independently and execute high-level research; and
4. Communicate effectively both orally and in written form and function on an interdisciplinary team, particularly in a laboratory setting.

G.3. Program Evaluation

This section does not apply to the Ph.D. program.

G.4. Course Descriptions & Program Requirements

G.4.1. Admission Requirements

The Program welcomes exceptional students with at least a 3.3 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, 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 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 or CAP faculty. A minimum of two ECE or CAP 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 18 hours of dissertation-related research) of study beyond the Master's degree or complete a minimum of 60 graduate credit hours (including 18 hours of dissertation-related research) of study beyond the bachelors' degree.
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 of passing qualifying exam), administered by the dissertation committee, on the core subjects and declared concentration;
4. Develop and defend a dissertation proposal within the first four years of admission; and

5. Complete and successfully defend a dissertation based on timely and original research in a relevant area of Secure Embedded Systems within the six years of enrollment;
6. The dissertation committee chair must determine the original contribution of the dissertation work.

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 core courses and must maintain a cumulative GPA of 3.5. 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 Secure Embedded Systems 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.

Core Courses	12 credits
Elective Courses	12 credit
Research Courses	18 credits
Dissertation Research	18 credits
Total	**60 credits**

Table D: Credit breakdown for students pursuing a Ph.D. directly from bachelors' Degree (60 credits required beyond a Bachelors' Degree).

Core Courses *or* Elective Courses *or* Research Courses	18 credits
Dissertation Research	18 credits
Total	**36 credits**

Table E: Credit breakdown for students pursuing a Ph.D. directly from master's degree (36 credits required beyond a master's degree).

Masters in Electrical Engineering, Advanced Computing, Computer Science, or Computer Engineering
Masters in Software Engineering
Masters in Information Systems
Approved Masters Degree in Related Areas

Table F: List of approved master's degree programs for direct admission to the Ph.D. program

Students with a master's degree in the approved areas listed in Table F will be required to take a minimum of 18 credits of core, elective and/or research courses and 18 credits of Dissertation Research. 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 F will be required to take a minimum of 4 core courses totaling 12 credits, and a minimum of 18 credits of Dissertation research. Students in the Bachelors to Ph.D. track will receive an *en passant*, or "along-the-way," masters degree, Master of Science in Secure Embedded Systems after completing 30 credits in the program.

The required core courses are listed below.

Course Number	Course Title	Credits
EEGR 580	Advanced Cybersecurity	3.0
EEGR 581	Advanced Networking	3.0
EEGR 679	Advanced Cryptography	3.0
EEGR 705	Algorithm Foundations for Cybersecurity Applications	3.0

Table G: Core courses

Students can choose electives courses from the following list of courses at Table H. Students can also have outside electives courses as approved by the Program Director.

Course Number	Course Title	Credits
EEGR 571	Advanced Hardware Reverse Engineering	3.0
EEGR 582	Advanced Communication Systems	3.0
EEGR 583	Advanced Risk management	3.0
EEGR 735	Advanced Digital VLSI	3.0
EEGR 745	Advanced Secure Embedded Systems	3.0
EEGR 750	Trustworthy Machine Learning	3.0
EEGR 755	Advanced Software Assurance	3.0
EEGR 760	Advance Digital Forensics	3.0
EEGR 765	Advanced Artificial Intelligence and Machine Learning	3.0
COSC 541	Scientific Visualization	3.0
BUAD 700	Quantitative Methods	3.0

Table H: Elective Courses

Course Number	Course Title	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 I: Research Courses

Course Number	Course Title	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 930	Dissertation Research VI	3.0

Table J: Dissertation Research Courses

Students finish the Ph.D. program with EEGR 930 or EEGR 997. If the dissertation is not completed with EEGR 930, the student should continue taking EEGR 997 until completion of the degree.

Residency Requirements

All candidates must satisfy eighteen 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 completion of all the course requirements and examinations, the candidate must continue to register for Dissertation Research VI each semester until they successfully defend.

Example Plan of Study

Below are two examples of a plan of study for a Ph.D. in Secure Embedded System.

Plan I: For students with an approved master's degree pursuing a Ph.D. in Secure Embedded System (36 credits)

First Semester (9 Credits)

- Core/Elective/Research Course 9 credits
- Take Qualifying Exam (Q Exam)

Second Semester (9 Credits)

- Core/Elective/Research Course 9 credits
- Take Pre-candidacy exam (A Exam)

Third Semester (9 Credits)

- Dissertation Research 9 credits

Fourth Semester (9 Credits)

- Dissertation Research 9 credits
- Dissertation Defense (B Exam)

Plan II: For students with a bachelor's degree pursuing a Ph.D. in Secure Embedded System (60 credits)

First Semester (9 Credits)

- Core Courses 6 credits
- Elective Courses 3 credits

Second Semester (9 Credits)

- Core Courses 6 credits
- Elective Courses 3 credits
- Take Qualifying Exam (Q Exam)

Third Semester (9 Credits)

- Elective Courses 6 credits
- Research Courses 3 credits

Fourth Semester (6 Credits)

- Research Courses 6 credits

Fifth Semester (9 Credits)

- Research Courses 9 credits
- Take Pre-candidacy Exam (A Exam)

Sixth Semester (9 Credits)

- Dissertation Research Courses 9 credits

Seventh Semester (9 Credits)

- Dissertation Research Courses 9 credits
- Dissertation Defense (B Exam)

G.4.4. Course Descriptions

EEGR 571 ADVANCED HARDWARE REVERSE ENGINEERING - Three lecture hours; 3 credits. Deals with security vulnerabilities in hardware design, physical tamper, and side-channel attacks to systems. Introduces fundamentals and practical techniques to design secure and trusted digital systems using assembly code analysis tools, IDA Pro, Wireshark, etc. Prerequisites: EEGR, 663. Students must pass EEGR 663 with a grade of "C" or better.

EEGR 580 ADVANCED CYBERSECURITY - Three lecture hours; 3 credits. This course provides a forward study of all aspects of cyber-security, including business, policy and procedures, communications security, network security, security management, legal issues, political issues, and technical issues. This course is a core course in the Ph.D. in the Secure Embedded Systems program. There are no prerequisites for this course.

EEGR 581 ADVANCED NETWORKING - Three lecture hours; 3 credits. This course presents the concepts in the many aspects of security associated with today's modern computer networks, including local area networks and the internet. It includes the fundamentals of network architecture, vulnerabilities, and security mechanisms, including firewalls, guards, intrusion detection, access control, malware scanners, and biometrics. This course is a core course in the Ph.D. in the Secure Embedded Systems program. Prerequisites: None.

EEGR 582 ADVANCED COMMUNICATION SYSTEMS - Three lecture hours; 3 credits. Consists of telecommunications systems design for point-to-point and mass data distribution, modulation techniques, propagation modes, and control methods. Advanced concepts of wireless and RF systems; the global system for mobile communications (GSM); code division multiple access (CDMA); and GPRS data protocols. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 583 ADVANCED RISK MANAGEMENT - Three lecture hours; 3 credits. This course presents an advanced background in the many aspects of the security management of modern communication networks. Topics include fundamentals of risk analysis and management, policy, operations, law, and secure system development. This course is a core course in the Ph.D. in Secure Embedded Systems program.

COSC 541: Scientific Visualization- Three Hours: 3 Credits**.** The course introduces principles, concepts, methods, techniques, algorithms, tools and strategies for scientific visualization. It covers topics such as perception, image techniques and data acquisition, surface extraction, volume visualization, methods for time-varying data, vector visualization, information visualization, virtual reality, and computer animation.

EEGR 679 ADVANCED CRYPTOGRAPHY - Three lecture hours; 3 credits. This course will provide practical knowledge on a wide range of cryptography mechanisms and will explore their relationship with today's modern communications and networks. It includes the fundamentals of cryptography, classic and contemporary encryption, decryption, public and private vital structures, digital signature, and secure hash functions. This course is a core course in the Ph.D. in Secure Embedded Systems program.

BUAD 700 Quantitative Methods - Three Hours: 3 Credits**.** This course provides an intensive coverage

of mathematical principles, techniques, and applications relevant to the study of business and economics.

EEGR 705 ALGORITHM FOUNDATIONS FOR CYBERSECURITY APPLICATIONS - Three lecture hours; 3 credits. Mathematical modeling, design, analysis, and proof techniques related to computer engineering. Probability, logic, combinatorics, set theory, and graph theory, as they pertain to the design and performance of computer engineering systems. Techniques for the design and analysis of efficient computational methods from graph theory and networks. Understanding of the limits on the efficiency of such computational methods. Translation from mathematical theory to actual programming. The course emphasizes mathematical rigor. Prerequisites: NONE.

EEGR 735 ADVANCED DIGITAL VLSI - Three lecture hours; 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. Students in some sections may, on permission, fabricate VLSI chips via MOSIS. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 745 ADVANCED SECURE EMBEDDED SYSTEMS - Three lecture hours; 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. Prerequisites: EEGR 663 and EEGR 581. Students must pass EEGR 663 and EEGR 581 with a grade of "C" or better.

EEGR 750 TRUSTWORTHY MACHINE LEARNING - Three hours; 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 helps 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. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 755 ADVANCED SOFTWARE ASSURANCE - Three hours; 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. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 760 ADVANCED DIGITAL FORENSICS - Three hours; 3 credits. This course addresses the tasks, processes, and technologies to identify, collect, preserve, and analyze data for use in a judiciary setting. This course focuses on building student skills to piece together the various components of the digital investigation. Through the use of a simulated lab environment, students will respond to realistic scenarios from the very awareness of a suspected security incident to the ultimate conclusion. Design projects are an integral part of this course. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 765 ADVANCED ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING - Three hours; 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. Prerequisites: EEGR, 580. Students must pass EEGR 580 with a grade of "C" or better.

EEGR 805 Pre-Candidacy Research I - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 810 Pre-Candidacy Research II - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 815 Pre-Candidacy Research III - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 820 Pre-Candidacy Research IV - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 825 Pre-Candidacy Research V - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 830 Pre-Candidacy Research VI - Three hours; 3 credits. The Ph.D. student develops a scholarly research plan in consultation with the student's dissertation committee chairperson.

EEGR 905 Dissertation Research I - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

EEGR 910 Dissertation Research II - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

EEGR 915 Dissertation Research III - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

EEGR 920 Dissertation Research IV - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

EEGR 925 Dissertation Research V - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

EEGR 930 Dissertation Research VI - Three hours; 3 credits. This course enables a Ph.D. candidate to execute the scholarly research plan in consultation with the student's dissertation chairperson and committee.

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

G.5. General Education Requirements

As a graduate-level program, 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 Secure Embedded Systems design at John Hopkins University (JHU). A copy of the Memorandum of Understanding (MOU) between Morgan and John Hopkins University follows.

Graduate Engineering Education Partnership Agreement
between
Morgan State University
and
Johns Hopkins University Whiting School of Engineering

This agreement specifies the practices and processes of the educational partnership between Morgan State University and the Johns Hopkins University Whiting School of Engineering in support of graduate education at Morgan State and increasing the cooperation between Morgan State University and the graduate programs in the Whiting School of Engineering.

We affirm the dedication of this partnership between Morgan State University and the Johns Hopkins University Whiting School of Engineering in providing expanded educational opportunities to graduate engineering and applied science students at Morgan State University and to diversifying the graduate students taking courses in the Whiting School of Engineering.

Earl S. Richardson
President
Morgan State University

Date: 12-1-2008

William R. Brody
President
Johns Hopkins University

Date: 11-16-2008

Eugene M. DeLoatch
Dean
School of Engineering
Morgan State University

Date: 11/19/08

Nicholas P. Jones
Dean
Whiting School of Engineering
Johns Hopkins University

Date: 11/14/08

Memorandum of Understanding

Graduate Engineering Education Partnership Agreement between Morgan State University and Johns Hopkins Whiting School of Engineering

Purpose

It is the purpose of the memorandum of understanding to provide the basis for the establishment of operational relationships between Morgan State University and the Johns Hopkins Whiting School of Engineering in support of providing engineering and applied science graduate students at Morgan State University the opportunity to take advanced courses from the Whiting School of Engineering.

Goals

The major goals which the institutions wish to accomplish are:

1) To provide expanded educational opportunities to full-time graduate students at Morgan State University in either engineering or applied science programs by allowing them to enroll in and take for credit any advanced course (300-level or above) offered by the Johns Hopkins Whiting School of Engineering.
2) To enhance diversity in the Whiting School of Engineering by encouraging students from Morgan State to enroll in classes offered by the Whiting School.
3) To strengthen the relationship between Morgan State University and the Whiting School of Engineering.

Academic Policies

1) Full-time graduate students in engineering and the applied sciences at Morgan State University may register for one (1) upper-level (300 or above) course per semester (Fall, Spring or Summer) in the Johns Hopkins Whiting School of Engineering. This includes courses offered by both the full-time program and by the Engineering and Applied Science Programs for Professionals (EPP).
2) Independent study and research type courses are not included in this agreement.
3) Courses must be taken for letter grade (A-F), satisfactory or unsatisfactory (S/U) or pass-fail (P/F) as designated by the Whiting School of Engineering.
4) Participating students must have taken any prerequisite courses required by the courses offered by the Whiting School of Engineering or have written permission from the instructor to register.

5) Participating students are responsible for ascertaining the dates, locations and times of all examinations, tests, tutorials, classes, etc. required. Participating students are responsible for attendance in Whiting School classes even when classes are not in session at Morgan State.

6) Morgan State students taking courses in the Whiting School are subject to the academic regulations of the Whiting School of Engineering. Participating students are required to acquaint themselves with both the academic and non-academic regulations of the Whiting School. These may include, but are not limited to, class attendance or absences, deadlines for grading options, deadlines for course changes and/or withdrawals, policies regarding academic misconduct, and final examination dates.

7) Participating students who violate the Whiting School's academic policies regarding cheating and plagiarism are subject to the Whiting School's disciplinary procedures for handling such matters. The Vice Dean for Education in the Whiting School of Engineering will notify the Dean of Engineering at Morgan State of the incident, actions taken, and appeal procedures. Further action by the Whiting School is left to the discretion of the Johns Hopkins University.

8) Participating graduate students are subject to applicable non-academic regulations and penalties of the Whiting School of Engineering which include, but are not limited to the student code of conduct, parking, library access and usage, technology access and usage.

9) Participating students register for any course in the Whiting School through the Registrar at Morgan State University. Registration is confirmed through existing procedures between home and host institutions.

10) Courses and grades earned in any of the Whiting School of Engineering programs are posted on the student's record at Morgan State in accordance with existing institutional policies and procedures. Notations regarding where a course was taken and where feasible, varying sub-topics, should be made on the student's records at Morgan State.

11) Final grades earned by participating students are reported to the Registrar at Morgan State. Grades may be released to participating students by the Whiting School in accordance with existing Whiting School academic policies.

12) Participating students pay tuition and fees on a semester or per credit hour basis to Morgan State University. Occasionally, some courses require additional fees to cover materials, facilities, or equipment and cannot be waived. These fees must be paid directly to the Whiting School.

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 on the Morgan website, and copies in paper form can are in the University Library, School/College, and Department Offices. Also, details may also be found at the Cybersecurity Assurance and Policy (CAP) Center website at www.iotcream.com.

G.9. Advertising, Recruiting, and Admissions Material

The ECE Department has Offices/Services to support Advertising, Recruiting, Admission. The Department also provides program materials. The Program faculty members write these materials for distribution. Advertisement of the program will include 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 embedded systems, hardware/software assurance, cybersecurity, cryptography, artificial intelligence, and machine learning. Thirteen (13) faculty are part of this Program. A list of the faculty is below.

First Name	Last Name	Appointment Type	Degree/Field	Academic Title/Rank	Status	Course Assignment
Kevin	Kornegay	Tenured	Ph.D./EECS	IoT Security Professor & Director of Cybersecurity Assurance and Policy (CAP) Center	Full-Time	Advanced Secure Embedded Systems, Special Topics in Embedded Systems
Paul	Wang	Tenured	Ph.D./CS	Professor & Chair	FT	Advanced Cybersecurity
Michel	Kornegay	Tenured	D. Eng./ECE	Associate Professor	FT	Advanced Digital VLSI
Kofi	Nyarko	Tenured	D. Eng./ECE	Associate Professor	FT	Advanced Artificial Intelligence and Machine Learning
Eric	Sakk	Tenured	Ph.D./ECE	Associate Professor	FT	Advanced Cryptography, Special Topics in Cryptography
Ketchiozo	Wandji	Tenure-Track	Ph.D./ECE	Associate Professor	FT	Advanced Risk management, Special Topics in Software Assurance
Onyema	Osuagwu	Tenure-Track	Ph.D./ECE	Associate Professor	FT	Trustworthy Machine Learning, Special Topics in Artificial Intelligence and Machine Learning
Md Tanvir	Arafin	Tenure-Track	Ph.D./ECE	Assistant Professor	FT	Advanced Hardware Reverse Engineering
Monireh	Debaghchian	Tenure-Track	Ph.D./CS	Assistant Professor	FT	Advanced Networking
Cliston	Cole	Tenure-Track (expected new hire)	Ph.D./ECE	Assistant Professor	FT	Advance Digital Forensics
Sanjay	Bapna	Tenured	Ph.D./MIS	Professor & Chair	FT	Analytical Decision-making for Business & Management
Gregory	Ramsey	Tenured	Ph.D./IDS	Associate Professor	FT	Data & Information Management
Hailu	Kassa	PostDoc	D. Eng./ECE	Adjunct Professor	FT	Advanced Communication Systems

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 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

Initially, this does not apply to this program. However, in the future, we plan to move to the distance instruction modality.

J. Adequacy of Library Resources

J.1. Library Resources

J.1.1. Morgan Library

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

J.1.2. Required Library Resources

The Ph.D. program requires modest additional library resources - books and journals on embedded system design, 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 embedded systems design 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 ECE Department will offer the Ph.D. program in secure embedded systems. It is administered by the Electrical and Computer Engineering Department, Schaefer Engineering Building (SEB) Room 224, and housed in existing laboratories located throughout SEB and on the 4th and 5th floors of the McMechen Hall Building.

K.1.2. Infrastructure Equipment

The Program will also leverage research infrastructure and equipment provided by the Cybersecurity Assurance and Policy Center and Center for Reverse Engineering and Assured Microelectronics (CREAM) Laboratory 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, SCMNS, and SOB facilities include many other laboratories that research artificial intelligence, cybersecurity, network security, and hardware/software assurance.

K.1.4. CREAM Laboratory

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 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 include the following hardware and software.

Hardware

- Tektronix DPO-7104C Digital Phosphor Oscilloscope for signal analysis.
- Agilent N9030 PXA Signal Analyzer for real-time spectrum measurements and countermeasure analysis.
- Embedded system application boards that include a variety of Xilinx Zynq based system-on-chips: pico- Zed, Zedboard, ZC702, ZC706, and ZCU102, as well as, other commercial ARM-based microprocessor embedded system application boards.
- Smart Home IoT Testbed includes commercial home automation system and devices: hub, smart lighting, sensors, smart garage door opener, smart door locks, etc., as well as, intelligent appliances, and voice-activated speakers (e.g., Alexa Echo).
- Smart Grid IoT Testbed is an advanced metering infrastructure (AMI) devices, which includes: smart meter, gatekeeper (collector), AMI access point to communicate with the monitoring station.
- Linksys WiFi router
- 24 desktop computers with dual monitors
- Riscure Side-Channel Analysis (SCA) and Fault Injection (FI) System
- JTAGulator
- Software-defined radios such as HackRF and Ettus
- Zwave controllers and sniffers
- Bluetooth transceivers
- Xilinx MPSOC, Zynq, and SDR, and a variety of ARM-based embedded system application boards
- A range of wireless and wired network appliances (e.g., routers and switches)
- Cloud storage devices

Software

- Xilinx Vivado and SDK tools.

- Metercat smart meter programming tool
- Inspector side-channel analysis software tool
- Tektronix TekVisa and SignalRF signal measurement and analysis tools
- Operating system platforms include MS Windows, XP, Ubuntu, and Kali Linux. Virtual machine hacker bundles with associated tools such as aircrack-ng, airplay-ng, and airmon-ng, Wireshark, etc.
- Sierraware TEE ARM Trustzone development tools
- Cadence
- ADS
- IDA Pro
- VMWare
- Amazon Web Services Tools
- Zwave device software development kit.

The simulation and RF/microwave measurement laboratories comprise two spaces. One space is 19 ft. X 34 ft. And houses two 16.5 ft. X 8 ft. Faraday cages, a measurement testbench that utilizes two spectrum analyzers (Anritsu @ 7 GHz), two power meters (Anritsu @ 3 GHz), an RF signal generator (Anritsu @ 3GHz) and computer. There is another shared test bench that utilizes a combination Vector Network Analyzer/ Noise Figure Meter. These test benches enable users to perform numerous RF measurements needed to evaluate the performance of RF/Microwave technologies. These measurements include calibration, 1dB gain compression, reflection, transmission, and noise parameters.

High-frequency characterization occurs in a 700 square foot space with an On-Wafer RF Characterization and Measurement system that is capable of handling measurement needs from DC up to 50GHz, and 90GHz-140GHz. A current memorandum of understanding with the Army Research Laboratory in Adelphi, Maryland, enables our team of researchers to obtain access to measurement capability in the frequency range between 50GHz–90GHz. The lab also has a Cascade Microtech Summit 10K Probe Station, 8510C Vector Network Analyzer, and a Keysight AT-N5245A PNA-X Programmable Network Analyzer that is capable of 110GHz operation. Additionally, we have a PNA-x VNA and a Cascade Microtech EPS 15MMW millimeter-wave probing system for broadband characterization up to 140GHz. The probe system incorporates a vibration isolation platform to ensure stable and repeatable wafer probe contact. The Simulation Laboratory has CAD tools such as Keysight's Advanced Design System (ADS), Applied Wave Research's Microwave Office (MWO), Ansoft Designer, and Ansys' High-Frequency Structure Simulator (HFSS) that support amplifier evaluation, design, and development.

K.1.5. Required Computer Resources

The proposed Ph.D. in Secure Embedded System requires additional computer hardware such as desktops, tablets, smartphones, etc. and computer-software resources, which are all furnished by the CAP Center.

K.2. Program Assurance in Distance Education

Morgan uses Google's Gmail for its email system, and Canvas [25] is the learning management system. The Ph.D. in secure embedded systems will use both traditional classroom and a Canvas for online course distribution.

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

L. Adequacy of Financial Resources with Documentation

L.1. Resources and Narrative Rationale

Table 1: PROGRAM RESOURCES					
	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	$0	$0	$0	$0	$0
2. Tuition/Fees Revenue	$168,840	$241,056	$339,300	$433,440	$533,520
a. Number of F/T Students	15	19	25	30	35
b. Annual Tuition/Fee Rate	$9,648	$10,044	$10,440	$10,836	$11,232
c. Total F/T Revenue (axb)	$144,720	$190,836	$261,000	$325,080	$393,120
d. Number of P/T Students	5	10	15	20	25
e. Credit Hour Rate	536	558	580	602	624
f. Annual Credit Hour Rate	9	9	9	9	9
g. Total P/T Revenue (d x e x f)	$24,120	$50,220	$78,300	$108,360	$140,400
3. Grants, Contracts & Other External Source	$1,240,000	$1,367,000	$1,650,000	$1,590,000	$1,620,000
4. Other Sources	$200,000	$250,000	$300,000	$350,000	$400,000
TOTAL (Add 1 -4)	**$1,608,840**	**$1,858,056**	**$2,289,300**	**$2,373,440**	**$2,553,520**

1. Reallocated Resources $0.00

2. Tuition /Fees Revenue $1,716,156

The graduate tuition & fees for both full time and part time graduate student includes a 3% increase every year for five years.

Year 1	Year 2	Year 3	Year 4	Year 5
$168,840	$241,056	$339,300	$433,440	533,520

3. Grants, Contracts & Other External Sources $7,467,000

Our funding for support will be based on current, pending and future opportunities. Currently, the table below are the estimates with opportunities with DHS, DoD, Dartmouth, University of Michigan, NSF just to name a few sources.

Year 1	Year 2	Year 3	Year 4	Year 5
$1,240,000	$1,367,000	$1,650,000	$1,590,000	$1,620,000

4. Other Sources $1,500,000

Other sources consist of corporate donations, student competitions and student fellowship opportunities (government/private).

Year 1	Year 2	Year 3	Year 4	Year 5
$200,000	$250,000	$300,000	$350,000	$400,000

5. Total $10,683,156

Year 1	Year 2	Year 3	Year 4	Year 5
$1,608,840	$1,858,056	$2,289,300	$2,373,440	$2,553,520

L.2. Program Expenditures and Narrative Rationale

Table 2: PROGRAM EXPENDITURES

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Faculty (b + c below)	**$0**	**$0**	**$0**	**$0**	**$0**
a. Number of FTE	0	8	8	8	8
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
2. Admin Staff (b + c below)	**$0**	**$0**	**$0**	**$0**	**$0**
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
3. Support Staff (b + c below)	**$0**	**$0**	**$0**	**$0**	**$0**
a. Number of FTE	0	0	0	0	0
b. Total Salary	$0	$0	$0	$0	$0
c. Total Benefits	$0	$0	$0	$0	$0
4. Technical Support & Equipment	**$50,000**	**$50,000**	**$50,000**	**$50,000**	**$50,000**
5. Library	**$0**	**$0**	**$0**	**$0**	**$0**
6. New or Renovated Space	**$30,000**	**$30,000**	**$30,000**	**$30,000**	**$30,000**
7. Other Expenses	**$0**	**$0**	**$0**	**$0**	**$0**
TOTAL (Add 1 - 7)	**$80,000**	**$80,000**	**$80,000**	**$80,000**	**$80,000**

1. **Faculty $0.00**

2. **Admin Staff $0.00**

3. **Support Staff $0.00**

4. **Technical support and equipment $250,000**

   There will be funds allocated to purchase required infrastructure support items such as computers, supplies, test equipment

Year 1	Year 2	Year 3	Year 4	Year 5
$50,000	$50,000	$50,000	$50,000	$50,000

5. **Library $0**

Year 1	Year 2	Year 3	Year 4	Year 5
$0	$0	$0	$0	$0

6. **New or Renovated Space $150,000**

   There will be approximately $30,000 allotted annually for painting, cleaning, repurposing rooms,

modernizing furniture, etc.

Year 1	Year 2	Year 3	Year 4	Year 5
$30,000	$30,000	$30,000	$30,000	$30,000

7. Other Expenses

Year 1	Year 2	Year 3	Year 4	Year 5
$0	$0	$0	$0	$0

8. Total $400,000

Year 1	Year 2	Year 3	Year 4	Year 5
$80,000	$80,000	$80,000	$80,000	$80,000

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Expenses	$80,000	$80,000	$80,000	$80,000	$80,000
Revenue	$1,608,840	$1,858,056	$2,289,300	$2,373,440	$2,553,520
Net Profit	$1,528,840	$1,778,056	$2,209,300	$2,293,440	$2,473,520

M. Adequacy of Provisions for Program Evaluation

Although there are no accreditation bodies like ABET, which evaluates undergraduate curriculum, Morgan's SoE and Department of Electrical and Computer Engineering have evaluation procedures for administrators (Dean, Department Chair), faculty, students, programs, and courses to use for this program.

Student assessment uses assignments, tests, quizzes, attendance, etc. Each semester, students will submit online evaluations for 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 assess faculty concerning their performance in the Secure Embedded Systems Program. Subsequently, the dean will determine the department chair, and the provost assesses the dean, and so on.

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

The purpose of the evaluations is to 1) build a more athletic 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, the development of a Performance Improvement Plan is necessary during the next semester or academic year and subject to approval 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 essential aspects of the course?
  - Is the grading system fair and clearly explained at the beginning of the semester?
  - Are assignments appropriately graded and promptly?
- Communication
  - Does the instructor explain complex ideas well?
  - Does the instructor show and inspire enthusiasm for the subject?
  - Do the instructor answer students' questions?
  - Does the instructor use example and illustrations to clarify material?
- Interaction with students
  - Does the instructor treat all students respectfully, honestly, 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 the 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 requirements:

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

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

M.1.4. Criteria for Student Learning Outcomes Evaluation

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

After completing the Ph.D. in secure embedded systems degree, students will have the knowledge and skills needed to successfully:

- Use current hardware/software assurance techniques to solve real-world embedded systems-oriented problems
- Understand and follow trends in embedded systems
- Function effectively in teaming environments to accomplish a common goal
- Exhibit professional, ethical, legal, security, and social issues and responsibilities
- Communicate effectively both in writing and orally.

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

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

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

O. Relationship to Low Productivity Programs Identified by the Commission

O.1. Relationship to Low Productivity Program

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

P. Adequacy of Distance Education Programs

P.1. Affirmation of Distance Education Eligibility

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

The Office of Morgan Online was established in 2013, and a full-time Director was hired in 2014 as a function of the President's reorganization of his administration better to 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 entirely investing in its support of 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 are published in the Faculty Handbook to establish criteria and guidelines for the development and delivery of high quality online and hybrid courses and online programs.

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

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

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

Appendix I. Morgan State University

Morgan is Maryland's preeminent public urban research university, and the only university designated a National Treasure. Founded in 1867, the Baltimore-based HBCU is celebrating its 152nd of excellence in higher education.

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

Morgan has a High Research Activity (R2) Carnegie classification.

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

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

Morgan has academic Programs at both undergraduate and graduate levels:

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

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

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

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

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

Appendix II. School of Engineering

The School of Engineering consists of four departments, namely:

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

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

- Bachelor of Science in Civil Engineering
- Bachelor of Science in Electrical Engineering
- Bachelor of Science in Industrial Engineering
- Bachelor of Science 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 robust 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, hardware assurance, reverse engineering, software assurance, signal processing, microwave systems, solid-state electronics, controls and automation, power, computer engineering, and cybersecurity. Computer engineering and cybersecurity are unique components of the electrical engineering (EE) program, where the Department offers a concentration. These courses expand and round out the curriculum 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 professor, seven tenured/tenure-track associate professors, two tenure-track assistant professors, seven full/part-time lecturers, and one 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. Farzad Moazzami (farzad.moazzami@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. Getachew Befekadu (getachew.befekadu@morgan.edu)
  - Dr. Cliston Cole (cliston.cole@morgan.edu)
  - Dr. Md Tanvir Arafin (mdtanvir.arafin@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 the 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 intend to grow Morgan's future by implementing the strategic initiatives for each purpose. The goals include:

Goal 1: Enhancing Student Success

Morgan offers an educational environment that enhances student success by hiring and retaining well-qualified, experienced, and dedicated faculty and staff, delivering rigorous academic curricula while 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, new initiatives that enhance doctoral success 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 grow its human capital and financial resources by investing in faculty, staff, and student development, seeking financial support from alumni, State and federal agencies, private, and philanthropic sources. Morgan will revisit the indirect costs issue associated with contracts and grants.

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 valuable 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 additional campuses and addressing deferred maintenance

Enhancing Doctoral Research University Standing

Targets: Carnegie R1 rating, increased contracts, and grant amounts strengthened Computer Science Department, School of Engineering expansion, the 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 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

The weblink for the complete copy of the document is https://issuu.com/Morganstateu/docs/strategicplan2011-21_final?e=2119971/60089621.