UNIVERSITY OF MARYLAND EASTERN SHORE
Office of the President

March 17, 2025

Sanjay Rai, Ph.D.
Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street, 10th Floor
Baltimore, Maryland 21201

RE: Substantial Change Proposal (Bachelor of Science degree in Electrical Engineering)

Dear Secretary Rai:

The University of Maryland Eastern Shore hereby submits a substantial change proposal to begin offering a Bachelor of Science degree in Electrical Engineering (BSEE) within the School of Business and Technology.

Consistent with its mission, UMES seeks to expand its capacity to offer unique and/or critical certificate and degree programs. As such, UMES has developed a Bachelor of Science in Electrical Engineering (BSEE). This new program will be established in the Department of Engineering and will complement the university's current undergraduate programs in Engineering. The proposed BSEE program aims to offer prospective students the opportunity to pursue a Bachelor of Science degree in electrical engineering and take the inside track to a career that combines engineering and technology and study the properties of electric and magnetic phenomena to the benefit of society.

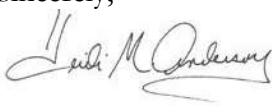
The proposed degree program will position UMES at the forefront of educational innovation in STEAM related academic programs. The proposed Electrical Engineering program will go beyond the current General Engineering (electrical specialization) program offered and will strengthen the workforce in the State of Maryland. It will also expand the pipeline of students entering the mainstream electrical engineering field. Electrical engineering remains in demand all over the world due to its versatile applications across various industries. The proposed BSEE program is expected to enable a stronger and multi-disciplinary research collaboration across the campus community, thus fueling research forward in many other disciplines beyond those created in applied science and engineering disciplines and creating a much broader impact on the Eastern Shore community as well as the State of Maryland.

The UMES campus is in Somerset County, Maryland. The BSEE will expand the educational opportunities for educationally disadvantaged students by developing a high-quality and innovative academic program that aligns with the educational needs of the region and the state of Maryland. The mission of the proposed program is to provide students and working professionals with advanced training in the discipline and to contribute to the economic development in the state of Maryland, especially in the Eastern Shore region where learning opportunities in advanced engineering disciplines are severely limited.

The attached proposal has undergone the established UMES curriculum approval process and I fully support the proposed program.

Thank you for your consideration.

Sincerely,



Heidi M. Anderson, Ph.D., FAPhA
President

Copy: Dr. Rondall Allen, Provost and Vice President for Academic Affairs
Dr. Derrek Dunn, Dean, School of Business and Technology
Dr. Yuanwei Jin, Department Chair, Department of Engineering

Office Use Only: PP#

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

Institution Submitting Proposal	University of Maryland Eastern Shore

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 # JJ524288 ( ) Check # JJ524288
Payment Amount: $850
Date Submitted: 3/10/2025

Department Proposing Program	Engineering and Aviation Sciences	
Degree Level and Degree Type	Bachelor of Science	
Title of Proposed Program	Electrical Engineering	
Total Number of Credits	120	
Suggested Codes	HEGIS: 0909	CIP: 14.1001
Program Modality	(●) On-campus ( ) Distance Education (fully online) ( ) Both	
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources	
Projected Implementation Date (must be 60 days from proposal submisison as per COMAR 13B.02.03.03)	(●) Fall ( ) Spring ( ) Summer	Year: 2025
Provide Link to Most Recent Academic Catalog	URL: http://catalog.umes.edu/index.php	
Preferred Contact for this Proposal	Name: Leesa Thomas Banks	
	Title: Interim Vice Provost for Academic Affairs	
	Phone: (410) 651-7591	
	Email: lpthomasbanks@umes.edu	
President/Chief Executive	Type Name: Heidi M. Anderson	
	Signature: Heidi M Anderson	Date: 03/17/2025
	Date of Approval/Endorsement by Governing Board:	

Revised 1/2021

Proposal for New Undergraduate Degree Program

Bachelor of Science in Electrical Engineering (BSEE)

A. Centrality to Institutional Mission Statement and Planning Priorities

1. Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.

The Department of Engineering and Aviation Sciences proposes to establish a Bachelor of Science degree in Electrical Engineering (BSEE) within the School of Business and Technology (SBT) at UMES. Electrical Engineering (EE) is a broad field that impacts many industries, including aerospace, telecommunications, artificial intelligence, and robotics. Electrical engineers design, develop, test, build, install, and maintain electrical equipment and systems. Some common specialties within electrical engineering include energy and power systems, semiconductor and electronic component manufacturing, research and development, signal processing, and control engineering. The proposed EE program aims to offer prospective students the educational opportunity to pursue a Bachelor of Science degree in electrical engineering and take the inside track to a career that combines engineering and technology to find ways to improve the quality of human life.

The curriculum of the program consists of core engineering courses, supportive science and math courses, and major electives, in addition to general education courses. This curriculum is designed to offer both a core understanding of traditional engineering disciplines, and an in-depth knowledge of the body. Our courses emphasize experimental and analytical coursework to gain a strong understanding of electrical and electronics engineering principles, systems, and applications for real-world problem solving.

The institutional mission of UMES, as an 1890 HBCU land-grant institution, is to promote distinctive learning, discovery and engagement opportunities in the arts and sciences, education, technology, engineering, agriculture, business and health professions. Central to this purpose is the guided interest in providing individuals, including first generation college students, access to a holistic learning environment that fosters multicultural diversity, academic success, and intellectual and social growth. The proposed program imbibes itself in this mission and it is guided by the opportunity to increase the graduation rate of the underrepresented minorities in the fields of electrical and electronics engineering.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

The proposed BSEE program supports the institution's strategic goals. According to the UMES Strategic Plan 2023, (see the link https://wwwcp.umes.edu/president/strategic-plan/), we identified the following three goals under the 3 Priorities:

- Priority 1: Academic Excellence and Innovation: "Goal 1.1: Attract, retain, and graduate more aspiring students at the undergraduate and graduate levels"
- Priority 2: Access, Affordability, and Achievement: "Goal 2.1: Increase Enrollment".
- Priority 3: Workforce and Economic Development: "Goal 3.3 Diversify and strengthen Maryland's knowledge workforce by expanding the pipeline of underrepresented minority students entering critical workforce fields (STEAM, cyber, health care, education, social work, human services, technology)".

The proposed degree program will help the institution achieve its strategic goals listed above and position UMES to the forefront of educational innovation in STEAM related academic programs. The proposed Electrical Engineering program is to go beyond the current General Engineering (electrical specialization) program that we offer to students to diversify and strengthen the tech workforce for the State of Maryland and to expand the pipeline of underrepresented minority students entering the mainstream electrical and electronics engineering field characterized by industry. According to Bureau of Labor statistics, nationwide, overall employment of electrical and electronics engineers is projected to grow 5 percent from 2022 to 2032, faster than the average for all occupations. About 17,800 openings for electrical and electronics engineers are projected each year, on average, over the decade. Electrical engineers are in high demand and are essential to many industries, including transportation, healthcare, construction, robotics, aerospace, telecommunications, and artificial intelligence (AI), which are in short supply in the rural area of the Eastern Shore.

The proposed BSEE program is expected to enable a stronger and multi-disciplinary research collaboration across campus community, thus fueling research forward in many other different disciplines more than in applied science and engineering disciplines and creating a much broader impact on the entire campus as well as the Eastern Shore community.

3. Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L.)

With the commission of the Engineering and Aviation Science Complex, a $103 million investment from the state, the proposed program will be supported by about two dozen state-of-the-art engineering laboratories such as Robotics and Automation Lab, Micro-Electro-Mechanical Systems (MEMS) Lab with a class ISO 5 clean room, and Microwave Anechoic Chamber Lab, and Basic Circuit and Instrumentation Lab, etc. Two new engineering faculty members in EE were recruited to join the Department in Fall 2024, alongside the existing four faculty members in EE to support this proposed BSEE program. They will jointly develop courses and labs, deliver instruction, and establish vibrant research agendas in the field of EE. The new faculty lines will be funded by the HBCU settlement fund that UMES receives for the first five years of program implementation. By leveraging the existing BACHELOR OF SCIENCE in General Engineering

program, we anticipate adequate resources for faculty lines and laboratories for instruction and research in the field of EE to ensure success of this degree program.

4. **Provide a description of the institution's a commitment to:**
    a) **ongoing administrative, financial, and technical support of the proposed program**

The University Administration is committed to adequately funding this program and it has made this program one of the priority areas of extending the footprint of the institution. With the HBCU Lawsuit Settlement fund, UMES and the School of Business and Technology, and Department of Engineering and Aviation Sciences are equipped with the needed resources and are committed to supporting the program in every way, including ongoing administrative support, financial support, and technical support of the program.

    b) **continuation of the program for a period of time sufficient to allow enrolled students to complete the program.**

This degree program was created by leveraging, in part, the existing faculty and staff in the Departments of Engineering and Aviation Sciences at UMES, as well as the state-of-the-art engineering laboratories in the Engineering and Aviation Science Complex on UMES' campus. Two additional new full-time tenure-track faculty members with terminal degrees in the field of electrical engineering or a closely related field have been recruited to develop and deliver courses and labs for the program. The university is fully committed to continuing the proposed BSEE program for a sufficient period of time to allow enrolled students to complete the program.

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

1. **Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:**

    a) **The need for the advancement and evolution of knowledge**

Electrical engineers study electric and magnetic phenomena and exploit their unique and malleable properties to the benefit of society. Electrical engineers design, build, test, analyze, and document a full spectrum of simple to extremely complex electric and electronic devices, machines, systems, and sub-systems. There are many different sub-disciplines under the umbrella of electrical engineering. Individual sub-disciplines will determine the possible career path of electrical engineers. An abbreviated list of electrical engineering sub-disciplines includes electronic circuit and system design, Microelectronics and semiconductors, Electric power systems, transmission, distribution and maintenance, Control systems, Telecommunication systems, Signal and image processing, Optics and photonics devices and systems, Instrumentation, Embedded

hardware/software systems, Automotive electric systems, Aerospace electronics, and Remote sensing.

The need for the advancement and evolution of electrical and electronics technology demands academic programs such as the proposed BSEE program to educate and produce next generation researchers and engineers to handle challenges in the next generation technology evolution.

b) Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education

UMES is located in Maryland's Somerset County, which is among the poorest counties in the state according to the U. S. Census Bureau. Lack of educational opportunities and choices for minority and educationally disadvantaged students calls for development of high-quality and innovative academic programming to align academic programs with the educational needs of the region and the state of Maryland.

UMES currently offers the Bachelor of Science in General Engineering degree program on the Eastern Shore of Maryland. Electrical specialization is one of the four specializations. In the past 17 years since inception of the engineering program, there have been more than 160 graduates. Most of these students joined the technical workforce in industry, such as Lockheed Martin, Northrup Grumman, ASML, John Deere, etc. Among those graduates, more than a dozen former graduates are working in the Wallops Island area for NASA and its contractors. About two dozen or more of them went on to pursue graduate degrees (master's and doctorate) in electrical engineering, mechanical engineering, or engineering science in other engineering schools, including Dartmouth College, Rensselaer Polytechnical Institute, University of Maryland College Park, Old Dominion University, etc. The graduation and job placement data have demonstrated the success of the general engineering program at UMES.

However, the department has received feedback from graduates concerning their experiences while job seeking. Based on the feedback we received, we discovered that the nature of the General Engineering program, its name and the curriculum, may have hindered some from landing jobs in more technical areas as opposed to applicants who graduate with a mainstream degree such as Electrical Engineering. To be explicit, General Engineering (Electrical Specialization) is not the same as Electrical Engineering from the viewpoint of some of the employers. By establishing a BSEE degree program at UMES, we hope to remove the barrier for our graduates to entering the electrical and electronics engineering workforce. Furthermore, we have established a Master of Science in Electrical and Mechatronics Engineering (MSEME) degree at UMES. The proposed BSEE degree is expected to enable streamlined progression of our EE students to enroll in the MSEME program for graduate studies. We further anticipate the established BSEE program will

facilitate transfer students with associate degrees in electrical engineering from the community colleges in the State.

Electrical engineering provides the foundational technology for modern society—electronics for aircrafts and automobiles, electric vehicular technology, medical diagnostic and surgical systems, wireless technology for a connected world (and universe), and semiconductor chips for computing and artificial intelligence. The proposed electrical engineering program is expected to further enhance UMES's position as a top choice higher education institution for STEM education for minority and educationally disadvantaged students in the state and the surrounding regions with the goal of developing a pipeline of engineering and STEM workforce for the state.

c) The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs

The proposed BSEE program will significantly strengthen and expand the capability of UMES, one of the four HBIs in the state, to provide high quality and unique educational experiences to students. In the Maryland state, only Johns Hopkins University, University of Maryland, Morgan State University, and Capitol Technology University offer a Bachelor of Science in Electrical Engineering degree. However, all four institutions are located outside of the Eastern Shore region. The proposed BSEE program at UMES will increase the number of minorities with BSEE degrees in the fields of electrical and electronics engineering. It will also strengthen and expand the research capacity of UMES to provide high quality and unique educational programs.

2. Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education.

The proposed BSEE degree program is well aligned with the 2021-2025 Maryland State Plan for Postsecondary Education in all three areas: Access, Success, and Innovation.

Access – Ensure equitable access to affordable and quality postsecondary education for all Maryland residents.

The BSEE degree program is designed to prepare highly trained scientists and engineers at the undergraduate level in electronic circuit and system design, microelectronics and semiconductors, electric power systems, transmission, distribution, and maintenance, control systems, telecommunication systems, signal and image processing, optics and photonics devices and systems, instrumentation, embedded hardware/software systems, automotive electric systems, aerospace electronics, and remote sensing.

Under **Priority 1: Study the affordability of postsecondary education in Maryland**, the proposed BSEE degree program aims to provide equitable access to quality education for all

Maryland residents, including those from disadvantaged backgrounds, to help develop a strong electrical engineering workforce for the state.

Furthermore, the proposed BSEE program supports **Priority 4: Analyze systems that impact how specific student populations access affordable and quality postsecondary education**. The program at UMES will have a unique impact on students from disadvantaged backgrounds by enhancing their opportunities to pursue and succeed in electrical engineering.

Success – Promote and implement practices and policies that will ensure student success.

The practices and policies concerning the proposed BSEE degree program align with all existing policies at the University, ensuring student success. By offering a carefully developed curriculum, well-equipped engineering laboratory facilities, necessary equipment, and an adequate number of faculty members for advising and teaching, the proposed degree program will support student graduation and successful job placement.

Additionally, the proposed BSEE program contributes to achieving **Priority 5: Maintain commitment to high-quality postsecondary education in Maryland** and **Priority 7: Enhance the ways postsecondary education serves as a platform for lifelong learning**.

Innovation – Foster innovation in all aspects of Maryland higher education to improve access and student success

Specifically, the proposed BSEE degree program aligns with the "Innovation" goal of the State Plan, which aims to "foster innovation in all aspects of Maryland higher education to improve access and student success." The proposed program will also contribute to achieving the goal of "Economic Growth and Vitality," which focuses on supporting a knowledge-based economy through increased education and training while ensuring that Historically Black Institutions remain "competitive, both in terms of program and infrastructure," alongside Maryland's other state institutions.

Ultimately, this program supports **Priority 8: Promote a culture of risk-taking.** The proposed degree program will prepare highly qualified scientists and engineers to contribute to Maryland's economic growth and vitality by equipping them with new knowledge and skill sets in emerging technologies, ensuring they maintain the expertise needed to succeed in the workforce.

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

1. Describe potential industry or industries, employment opportunities, and expected level of entry (*ex: mid-level management*) for graduates of the proposed program.

A BSEE degree opens a plethora of opportunities across a broad spectrum of industries. Electrical engineers are sought after in diverse sectors such as energy, telecommunications,

manufacturing, defense, aerospace, automotive, and many more. This diversity of industries allows electrical engineers to apply their skills in various contexts, from designing smart grids for power distribution, to developing systems for autonomous vehicles, to crafting intricate circuit designs for advanced communication systems. Engineers often must solve complex problems, so an electrical engineer must be adept at creating, evaluating, and implementing solutions. Innovation in this area of engineering will no doubt continue in accordance with the development of technology. The proposed BSEE program will produce graduates in all technical fields, including as entry level engineers or engineering managers.

2. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.

The 2023 median pay for electrical engineers is $109,010 per year, and the median annual wage for electronics engineers, except computer was $119,200 in May 2023. Data by BLS (https://www.bls.gov/ooh/architecture-and-engineering/electrical-and-electronics-engineers.htm) shows that overall employment of electrical and electronics engineers is projected to grow 5 percent from 2022 to 2032, faster than the average for all occupations. About 17,800 openings for electrical and electronics engineers are projected each year, on average, over the decade. Many of those openings are expected to result from the need to replace workers who transfer to different occupations or exit the labor force, such as to retire.

A recent study on the job market for electrical engineers in the US (https://www.careerexplorer.com/careers/electrical-engineer/job-market/) shows that Maryland employed 4550 electrical engineers in the industry, ranked 13th in the nation. This shows that Maryland has the potential to further increase the number of employment opportunities in electrical and electronics engineering field. The BLS predicts that most opportunities for electrical and electronics engineers will be with engineering service firms, as companies seek to reduce costs by contracting. Electrical engineers familiar with developing technologies in the areas of solar arrays, semiconductors, and communications will be best positioned to find jobs.

Moreover, according to Occupational Information Network, i.e., O-Net Online, (https://www.onetonline.org/link/summary/17-2071.00), job titles suitable for graduates of the electrical engineering program vary, such as Circuits Engineer, Design Engineer, Electrical Controls Engineer, Electrical Design Engineer, Electrical Engineer, Electrical Project Engineer, Engineer, Instrumentation and Electrical Reliability Engineer (I&E Reliability Engineer), Project Engineer, Test Engineer. Their focuses are on research, design, development, testing, or supervision of the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use. Among those position titles, Industries with the highest concentration of employment in Electrical Engineers are listed in the table below: (https://www.bls.gov/oes/current/oes172071.htm)

Industry	Employment	Annual Mean Wage

Electric Power Generation, Transmission and Distribution	17,870	$115,480
Electrical Equipment Manufacturing	4,810	$96,850
Audio and Video Equipment Manufacturing	610	$122,340
Communications Equipment Manufacturing	2,370	$126,850
Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	10,890	$123,780

Finally, the Maryland Occupational Projections - Workforce Information and Performance has updated the projections of engineering jobs during the ten-year period of 2022-2032. It is anticipated that there will be an 8.43% increase of occupation in Architecture and Engineering in the state of Maryland. The proposed BSEE program will help meet the demand of the engineering workforce.

3. **Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.**

The employment data from the Bureau of Labor Statistics (BLS) is typically used to determine market demand. Data by BLS (https://www.bls.gov/ooh/architecture-and-engineering/electrical-and-electronics-engineers.htm) shows that overall employment of electrical and electronics engineers is projected to grow 5 percent from 2022 to 2032, faster than the average for all occupations. And about 17,800 openings for electrical and electronics engineers are projected each year, on average, over the decade. These openings are to be filled by those with educational and training background in the field of electrical engineering.

The career outlook for electrical engineers is strong. Industry data shows (https://www.recruiter.com/careers/electrical-engineers/outlook/) vacancies for this career have increased by 24.89 percent nationwide in that time, with an average growth of 1.56 percent per year. Demand for Electrical Engineers is expected to go up, with an expected 16,880 new jobs filled by 2029. This represents an annual increase of 1.01 percent over the next few years.

4. **Provide data showing the current and projected supply of prospective graduates.**

Similar electrical engineering Bachelor of Science programs that are offered by HBCUs in the region include: The University of District of Columbia, Morgan State University, and Howard University. In the State of Maryland, four institutions offer BSEE degrees, including The Johns Hopkins University, Morgan State University, University of Maryland College Park and The Capitol Technology University. Based upon data available to the public, the

number of degrees awarded in BSEE in the four Maryland institutions and other HBCUs in the region is summarized below:

Institutions	**# of EE BS Degree Awarded (recent)**
Morgan State University	46 (Spring 2023)
Johns Hopkins University	21 (2022-2023)
University of Maryland	100 (2022-2023)
Capitol Technology University	N/A
University of District of Columbia	11 (2022-2023)
Howard University	14 (2022-2023)

The data shows that the number of awarded Bachelor of Science degrees in electrical engineering from HBCU is still low. UMES is in a good position to address the shortage of HBCU graduates of a BSEE program. The four institutions in the state are more than 130 miles away from the UMES campus, which is on the Eastern Shore of Maryland. UMES is thus uniquely positioned to address this need within the State of Maryland. It is our belief that the market demand is sufficiently high, the geographic draw of students is sufficiently distinct and the proposed BSEE program to be offered on the Eastern Shore of the state, along with other similar programs in the state (e.g., JHU's BSEE, UMD's BSEE, and Morgan State University's BSEE) will provide valuable contributions to the Maryland workforce.

D. Reasonableness of Program Duplication

1. **Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.**

The proposed program is unique and building upon the existing faculty expertise in the general engineering program at UMES. There is no other electrical engineering degree program on the Eastern Shore of Maryland. By reviewing the MHEC Academic Program Inventory https://mhec.maryland.gov/institutions_training/pages/HEPrograms.aspx, we identify five Maryland institutions that offer BSEE degrees:

Keyword: Electrical Engineering
Degree: Bachelor's Degree
Total: 5

Institution	Program	Degree
Capitol Technology University	ELECTRICAL ENGINEERING	Bachelor's Degree
Johns Hopkins University	ELECTRICAL ENGINEERING	Bachelor's Degree
Loyola University Maryland	ELECTRICAL ENGINEERING	Bachelor's Degree
Morgan State University	ELECTRICAL ENGINEERING	Bachelor's Degree
Univ. of Maryland, College Park	ELECTRICAL ENGINEERING	Bachelor's Degree

Although five Maryland institutions - the University of Maryland, Morgan State University, Johns Hopkins University, Loyola University Maryland, and Capitol Technology University - offer a BSEE degree program, they are located approximately 130 miles from the Eastern Shore. **UMES serves a distinct geographical area compared to other regions of the state.** Moreover, the proposed program offers a unique curriculum with a focus on electronics, circuit design, and artificial intelligence—fields in which technical talent and workforce availability are critically lacking, especially in the rural Eastern Shore region. The proposed UMES BSEE program will complement existing BSEE programs in the state by addressing this gap.

2. Provide justification for the proposed program

Electrical engineers are in high demand and play a crucial role in various industries, including transportation, healthcare, construction, robotics, aerospace, telecommunications, and artificial intelligence (AI). They design, develop, build, test, and maintain electrical systems and equipment, such as electric motors, radar and navigation systems, communication systems, and power generation equipment. They also design electrical systems for automobiles and aircraft.

Most recently, the global competition for chip manufacturing has intensified the demand for electrical engineers. Developing new methods for microchip production is one of the many responsibilities of electrical engineers. The CHIPS and Science Act aims to boost chip manufacturing in the United States with a $50 billion investment. While this presents an exciting opportunity for the U.S. economy, it also highlights a major challenge: a severe shortage of qualified professionals needed to operate chip manufacturing plants and design the chips they will produce.

Engineering schools in the United States are now racing to produce that talent. There were around 20,000 job openings in the semiconductor industry at the end of 2022, according

to the recent article of IEEE Spectrum (https://spectrum.ieee.org/chips-act-workforce-development), which states that "Even if there's limited growth in this field, you'd need a minimum of 50,000 more hires in the next five years. We need to ramp up our efforts quickly."

As part of the national research community, UMES will join forces with other HBCUs in the effort to produce a qualified technical workforce. The proposed BSEE program expands beyond the existing General Engineering (Electrical Specialization) by eliminating potential barriers that may arise from the structure of the current program. This change will enable graduates to seamlessly enter the mainstream electrical engineering workforce.

The proposed BSEE program will equip students with both foundational and practical knowledge in various aspects of electrical and electronic system design and testing. BSEE graduates from UMES will play a pivotal role in bridging the diversity gap within the engineering field while fostering a generation of talented, diverse, and innovative engineers poised to shape the future of industries in the region, the state of Maryland, and beyond.

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

1. Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBI's.

Engineering programs with various sub-disciplines have always been in high demand on the employment spectrum. Only three HBCUs (Morgan State, Howard University, and University of District of Columbia) in the region offer electrical engineering programs at the baccalaureate level. And UMES is more than 160 miles away from these institutions. The proposed BSEE program at UMES, if established, will position UMES as a center for electrical and electronics technology education and research in the rural area of Eastern Shore. The program will enable UMES to produce a high caliber workforce in electrical engineering to support the aviation and aerospace industry, as well as the field of artificial intelligence, and chip manufacturing and design.

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

1. Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.

UMES has envisioned a strong presence in education and innovation in the STEAM field, and engineering is one of the focus areas. The proposed BSEE program at UMES, if established, will strengthen the position of UMES as a center for engineering education and research in the rural

area of the Eastern Shore, and thus reaffirming the mission of UMES as an 1890 land-grant institution. The program will enable UMES to produce a high caliber workforce in electrical and electronics engineering to support the high demand tech workforce in the region and the state.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10):

1. Describe how the proposed program was established, and also describe the faculty who will oversee the program.

Curriculum Design: The proposed program was established through a rigorous review of unmet needs by the institution. It started from the faculty in the engineering program, with approval from the Departmental Curriculum Committee, School Curriculum Committee, Graduate Faculty Council, Senate Curriculum Committee, etc. The curriculum was developed by the faculty in the Department of Engineering and Aviation Sciences.

Faculty Oversight: The courses of the curriculum in the proposed BSEE Bachelor of Science degree program will be taught by faculty in the Department of Engineering and Aviation Sciences, with Two (2) new full-time tenure-track faculty members with Ph.D. degrees in the electrical engineering fields. The two new faculty will develop courses and labs and deliver teaching and research in the electrical engineering field. In addition, the existing faculty in the department will also help with the BSEE because a significant number of courses in the core and elective of the BSEE curriculum are cross-listed in the courses in the existing General Engineering Program curriculum. This arrangement ensures the new BSEE program is fully supported in terms of faculty resources. Please view the detailed list of faculty backgrounds in EE in the current engineering program discussed later in this proposal.

Program Modality: The program will be offered at the main campus of UMES.

2. Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.

To ensure the curriculum of the BSEE program reflects the rigor and highest standards appropriate to the electrical engineering field, we will seek and maintain accreditation from the Engineering Accreditation Commission (EAC) of ABET, https://www.abet.org, under the commission's General Criteria and the Program Criteria for Electrical Engineering for this BSEE program.

The educational objectives of the curriculum of the proposed BSEE program are to enable graduates of the program to develop ability of:

- Contributing to solutions of engineering problems by applying their technical knowledge, their experience with modern industry tools, and their understanding of the impact that engineering can have on global, societal, and environmental issues.
- Assuming project/product management and team leadership roles in their organizations.

- Demonstrating growth in careers related to electrical engineering and becoming productive engineers and/or pursuing graduate studies
- Contributing to society through involvement in professional and/or service activities.

The learning outcomes of the program align with the learning outcomes of the ABET (1)-(7) specified by the Engineering Accreditation Commission (EAC).

- [1]. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- [2]. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economics factors.
- [3]. An ability to communicate effectively with a range of audiences.
- [4]. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- [5]. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- [6]. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- [7]. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Students will learn analytical and experimental methods that are broadly applicable in the field of engineering. They will also be given specific instruction and hands-on laboratory experimental leaning experiences on how to apply these methods to a large range of problems in biomedical engineering.

3. Explain how the institution will:

a) provide for assessment of student achievement of learning outcomes in the program

Assessment Methods based on established departmental standards will include the following:

- Assessing written and oral student presentations, written assignments and research projects.
- Evaluating student performance in exams, quizzes and assignments in required major courses.
- Assessing comprehensive senior design project report in the two tracks of the program.

b) document student achievement of learning outcomes in the program

The department will document student achievement of the learning outcomes in the program in the same fashion as its current accredited engineering undergraduate program periodically.

Assessment of learning outcomes will be conducted every six years per ABET accreditation requirements.

4. **Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements**

The Electrical Engineering BS program consists of **120** total credit hours. The number of credits is determined based upon the MHEC requirement for BS degree and a survey of credit requirement for similar mechanical engineering programs in the region. The curricula include 28 credit hours of general education courses in English, arts and humanities, social and behavioral sciences, and institution specific courses. An additional 11 credits in mathematics and physical sciences are required under the General Education program, which are included as a part of the requirements for the Electrical Engineering major. This makes the total credits for General Education to be 39 credit hours. The Electrical Engineering curriculum also requires 19 credits of supportive math and physics courses. Students take 51 credit hours of core electrical engineering courses. Students choose 11 credit hours of elective courses. The program is on a semester basis. The total number of credits and their distribution is given as follows:

	Category	***Distribution***
I.	General Education Courses	39 credit hours
II.	Supportive Math & Science Courses	19 credit hours
III.	Electrical Core Courses	51 credit hours
IV.	Elective Courses	11 credit hours

Electrical Engineering Core Requirement		**51 credits needed**
Course Code	**Course Title**	**Credit Hours**
ENGE 150	Modern Engineering Design	3 hrs
ENGE 170	Programming Concepts for Engineers	3 hrs
ENGE 240	Basic Circuit Theory	3 hrs
ENGE 241	Analog Circuit Lab	1 hrs
ENGE 250	Digital Logic Design	3 hrs
ENGE 251	Digital Logic Design Lab	1 hrs
ENEE 222*	Elements of Discrete Signal Analysis	3 hrs
ENEE 354*	Digital Circuits and Systems Design	3 hrs
ENGE 320	Statistics and Probability for Engineers	3 hrs
ENGE 340	Analog and Digital Electronics	3 hrs
ENGE 341	Analog and Digital Electronics Lab	1 hrs

ENGE 370	Computational Methods in Engineering	3 hrs
ENEE 330	Signals and Systems	3 hrs
ENEE 348	Electromagnetic Theory	3 hrs
ENGE 382	Control Systems	3 hrs
ENGE 383	Control Lab	1 hrs
ENEE 301*	Introduction to Device Physics	3 hrs
ENCE 350	Computer Organization	3 hrs
ENGE 475	Engineering Seminar	1 hrs
ENGE 476	Senior Design Project I	2 hrs
ENGE 477	Senior Design Project II	2 hrs

Electrical Engineering Elective		**11 credits needed**
Course Code	**Course Title**	**Credit Hours**
ENEE 450*	Electronic Circuit Design Lab	2 hrs
ENEE 385	Power Electronics	3 hrs
ENEE 448*	Electromagnetic Wave Propagation	3 hrs
ENEE 387	Simulation and Virtual Reality	3 hrs
ENEE 422	Introduction to Machine Learning	3 hrs
ENEE 444	Communication Design Lab	2 hrs
ENEE 452	Artificial Intelligence	3 hrs
ENEE 372	Computer Networks	3 hrs
ENEE 304*	Introduction to Micro and Nanoelectronics	3 hrs
ENCE 458	VLSI	3 hrs
ENEE 460	Digital Signal Processing	3 hrs
ENEE 465	Remote Sensing and Image Processing	3 hrs
ENEE 464	Embedded System Design Lab	2 hrs
ENEE 468	Robotics	3 hrs
ENEE 469	Robotics & Automation Design Lab	2 hrs
ENEE 472	Selected Topics in Engineering	3 hrs
ENEE 490*	Principle of Wireless Communications	3 hrs

ENCE 454	Computer System Architecture	3 hrs
ENCE 352	Microprocessors and Microcomputers	3 hrs
ENCE 465	Microprocessor Design Lab	2 hrs

Supportive Science & Math Requirement		**19 credits needed**
Course Code	**Course Title**	**Credit Hours**
MATH 211	Calculus II	4 hrs
MATH 212	Calculus III	4 hrs
MATH 241	Differential Equation for Engineers	3 hrs
PHYS 262	General Physics II	3 hrs
PHYS 264	Genera Physics II Lab	1 hrs
PHYS 263	General Physics III	3 hrs
PHYS 265	General Physics III Lab	1 hrs

Note: ENEE 222, ENEE 301, and ENEE 354 are new courses introduced to the major core of the BSEE curriculum, and ENEE 304, ENEE 448, ENEE 458 and ENEE 490 are new courses introduced to the electives of the BSEE curriculum. The rest of the course are in the existing BS general engineering curriculum and can be found in the UMES catalog (http://catalog.umes.edu/). This arrangement enables the existing engineering faculty to contribute to course offering to the proposed BSEE program.

Course Descriptions for Electrical Engineering Core:

ENGE 150 Modern Engineering Design (3 credits). An introduction to modern engineering design with emphasis on various aspects of developing a product via hands-on design approach, communication skills, and teamwork; use of product visualization and computer software such as word processing, power point, and spreadsheet; students work as teams to develop and design a working prototype. Prerequisite: MATH 109 College Algebra.

ENGE 170 Programming Concepts for Engineers (3 credits). Introduction to algorithms; overview of computers and programming; principles of software development; high level languages; C-programming; input/output; data types and variables; operators and expressions; selection structure; repetition; functions; arrays; pointers; strings; structure data types; linked list; stream and file management; debugging and documentation. Prerequisite: ENGE 150 Modern Engineering Design.

ENGE 240 Basic Circuit Theory (3 credits). The course focuses on basic circuit elements, resistors, capacitors, inductors, independent and dependent sources, and operational amplifier; Kirchhoff's laws; nodal and mesh analysis; superposition; Thevenin and Norton theorems; DC and AC steady state analysis; Transient analysis for first and second order circuits; and phasors. Prerequisite: MATH 211 Calculus I; Co-requisite: MATH 241 Differential Equations for Engineers, ENGE 241 Analog Circuit Lab.

ENGE 241 Analog Circuit Lab (1 credit) Introduction to basic measurement techniques and electrical laboratory equipment, power supplies, oscilloscopes, multi-meters, and function generators; experiments concerning principles taught in ENGE 240 Basic Circuit Theory course. Prerequisite: MATH 211 Calculus I; Co-requisite: ENGE 240 Basic Circuit Theory.

ENGE 250 Digital Logic Design (3 credits) This course is an introduction to number systems, elements of binary arithmetic and codes; Boolean algebra; Karnaugh map and simplification of gate networks; Quine-McCluskey method; adders, subtractors, comparators, multiplexers and demultiplexers, and PLAs; latches, flip-flops, shift registers, counters, and memories; design and analysis of combinational logic and synchronous sequential circuits. Prerequisite(s): ENGE 170 Programming Concepts for Engineers. Corequisite(s): ENGE 251 Digital Logic Design Lab.

ENGE 251 Digital Logic Design Lab (1 credits) This course introduces basic laboratory skills in operating digital test equipment, testing digital logic circuits, generating test inputs and analyzing outputs, and emphasis is placed on experiments concerning principles taught in ENGE 250 Digital Logic Design course. Prerequisite(s): ENGE 170 Programming Concepts for Engineers. Corequisite(s): ENGE 250 Digital Logic Design.

ENEE 222 Elements of Discrete Signal Analysis (3 credits) This course introduces the fundamental principles of discrete-time signal analysis. Topics include the representation of discrete-time and continuous-time signals, sampling of sinusoids. Discrete-time Fourier analysis, properties and applications. Periodic signals and Fourier series. Discrete-time linear filters in time and frequency domains. Numerical applications and implementation of algorithms (using MATLAB). Emphasis is placed on both the theoretical foundations and practical implementation of discrete time signal analysis techniques in engineering applications. Prerequisite: ENGE 170 (Programming Concepts for Engineers)

ENEE 354 Digital Circuits and Systems (3 credits) This course focuses on the analysis, design, and implementation of digital circuits and systems. Topics include combinational and sequential logic design, logic minimization techniques, finite state machines, arithmetic circuits, memory systems, and an introduction to hardware description languages (HDLs) for digital design. Students will explore the design and simulation of digital systems using modern tools and techniques. The course emphasizes the practical application of concepts to develop reliable and efficient digital circuits. Prerequisite: ENGE 250 (Digital Logic Design)

ENGE 320 Statistics and Probability for Engineers (3 credits) Probability; random variables and processes; discrete and continuous distributions and densities; collection and presentation of

sample data; frequency distributions and histograms; confidence intervals; hypothesis testing; basic problems of statistical inference; linear regression and correlation; designing engineering experiments. Prerequisite: MATH 211 Calculus II

ENGE 340 Analog and Digital Electronics (3 credits) Conceptual operation of PN-junction diodes, bipolar junction transistors (BJTs), and mono-oxide semiconductor field effect transistors (MOSFETs); transistor circuits for inverters, NAND, and NOR gates; semiconductor memory; large and small signal characteristics of diodes and transistors; basic transistors configurations; DC bias and small signal analysis of BJTs and MOSFETs; multiple-transistor circuits such as operational and differential-amplifiers; frequency response of simple amplifiers. Prerequisite(s): ENGE 240 Basic Circuit Theory; Corequisite(s): ENGE 341 Analog and Digital Electronics Lab.

ENGE 341 Analog and Digital Electronics Lab (1 credit) This course provides laboratory experiments concerning topics taught in ENGE 340 analog and digital electronics course. Prerequisite(s): ENGE 241 Analog Circuit Lab. Corequisite(s): ENGE 340 Analog and Digital Electronics.

ENGE 370 Computational Methods in Engineering (3 credits) Fundamentals of linear algebra and basic operations of vectors and matrices; error analysis; solution of a system of linear equations; iterative solution of nonlinear equations; numerical integration; numerical solution of differential equations; introduction to Matlab software; programming and applications relating to the computational functions in Matlab. Prerequisite: MATH 211 Calculus II; Co-requisite: MATH 241 Differential Equations for Engineers.

ENEE 330 Signals and Systems (3 credits) In this course, the concept of linear systems, state space equations for continuous and discrete systems, time domain analysis of linear systems, Fourier, Laplace, and z-transforms and application of theory to problems in general engineering are examined. Prerequisite(s): MATH 241 Differential Equations for Engineers and ENGE 240 Basic Circuit Theory.

ENEE 348 Electromagnetic Theory (3 credits) This course offers an introduction to electromagnetic fields; Coulomb's law; Gauss' law; electrical potential; dielectric materials; capacitance; boundary value problems; Biot-Savart law; Ampere's law; Lorentz force equation; magnetic materials; magnetic circuits; inductance; time varying fields and Maxwell's equations. Prerequisite(s): MATH 241 Differential Equations for Engineers and PHYS 263 General Physics III.

ENCE 350 Computer Organization (3 credits) This course introduces the structure and function of computers, digital computer organization, design of digital computer at the machine and microprogramming level, assembly language programming concepts, data and instruction formats, architecture of the central processing unit, input-output peripherals, registers, memory unit, addressing modes, subroutines and their linkages. Prerequisite(s): ENGE 250 Digital Logic Design.

ENEE 301 Introduction to Device Physics (3 credits) This course provides a foundational understanding of the physical principles governing electronic and optoelectronic devices. Topics include crystal structures, energy bands in solids, charge carriers in semiconductors, carrier transport phenomena, p-n junctions, and the operational principles of diodes, transistors, and other semiconductor devices. The course emphasizes the relationship between material properties and device performance, laying the groundwork for advanced studies in electronic and photonic devices. Prerequisite: ENGE 240 (Basic Circuit Theory)

ENGE 382 Control Systems (3 credits) This course covers mathematical models of control system; Laplace transform; signal flow graph; frequency and time domain characteristics of the system response; methods of linear control system analysis and designs, root locus, Bode, and Nyquist plots; stability theory; design specifications in time and frequency domains; compensator design; PID controller design. Prerequisite: MATH 241 Differential Equations for Engineers and ENGE 261 Dynamics; Co-requisite: ENGE 383 Control Lab.

ENGE 383 Control Lab (1 credits) This laboratory course provides practical hands-on training and experience with methods used in modeling, analysis, simulation, and control of engineering systems. Laboratory experiments cover topics taught in ENGE 382 Control Systems course. MATH 241 Differential Equations for Engineers and ENGE 261 Dynamics; Co-requisite: ENGE 382 Control Systems.

ENGE 475 Engineering Seminar (1 credits) This is a general seminar course that covers current topics in engineering. Prerequisite(s): Permission of instructor and Senior Standing.

ENGE 476 Senior Design Project I (2 credits) Students are introduced to a design project to demonstrate their ability to engage in the practice of engineering as a profession. Students in consultation with the supervising professor and course coordinator must identify and implement a design project. The topic may be analytical, numerical, experimental, or field-oriented, utilizing knowledge gained from academic and research experiences integrated in the curriculum. Use of professional engineering standards and a design approach are required. Prerequisite(s): Senior standing and permission of instructor. A written proposal, literature search, and an oral presentation are required. Prerequisite: Senior Standing and Permission of Instructor

ENGE 477 Senior Design Project II (2 credits) This course is a continuation of ENGE 476 Senior Design Project I, with the same standards and requirements. Prerequisite(s): ENGE 476. A progress report, a final report, and an oral presentation are required.

Course Description for Electrical Engineering Electives:

ENEE 450 Electronic Circuit Design Lab (2 credits) This laboratory course focuses on the design, construction, and testing of electronic circuits. Students will work on practical projects

involving analog and digital circuit design, emphasizing real-world applications. Topics include amplifier design, feedback systems, oscillators, filters, and mixed-signal circuits. The course develops skills in using modern laboratory equipment, circuit simulation tools, and troubleshooting techniques to enhance students' ability to analyze and optimize circuit performance. Prerequisite(s): ENGE 341 Analog and Digital Electronics Lab

ENEE 448 Electromagnetic Wave Propagation (3 credits) This course explores the principles and applications of electromagnetic wave propagation in various media. Topics include Maxwell's equations, plane wave solutions, reflection and transmission at interfaces, waveguides, antennas, and radiation. Emphasis is placed on understanding wave behavior in practical systems such as communication devices, radar, and optical systems. Students will develop analytical and problem-solving skills to address real-world challenges in electromagnetic engineering. Prerequisite(s): ENEE 348 (Electromagnetic Theory)

ENEE 490 Principle of Wireless Communications (3 credits) This course introduces the fundamental principles of wireless communication systems. Topics include wireless channel characteristics, modulation and demodulation techniques, channel coding, multiple access methods, cellular network architecture, and an overview of modern wireless standards. Emphasis is placed on understanding the challenges of wireless communication, such as fading, interference, and bandwidth limitations, and on techniques to address these challenges in practical systems. Prerequisite: ENEE 330 (Signals and Systems)

ENEE 304 Introduction to Micro and Nanoelectronics (3 credits) This course introduces the fundamental principles of microelectronics and nanoelectronics, focusing on the operation, modeling, and applications of semiconductor devices. Topics include the physics of semiconductors, p-n junctions, MOSFETs, BJTs, and emerging nano electronic devices. Emphasis is placed on the analysis and design of circuits using these devices, as well as the impact of scaling on device performance in modern micro and nanoscale technologies. Prerequisite(s): ENEE 240 (Basic Circuit Theory)

ENEE 387 Simulation and Virtual Reality (3 credits) This course is an introduction to computer simulation and virtual reality; fundamental of 3-D simulation modeling; analysis of model output; interaction devices for virtual environments; physical based simulation; virtual prototypes; data exchange and data communication; user interfaces and interactive applications; complete virtual reality systems; using simulation and virtual reality software for modeling. Prerequisite(s): ENGE 370 Computational Methods in Engineering.

ENEE 422 Introduction to Machine Learning (3 credits) This course provides an overview of machine intelligence and the role of machine learning for making informed data-driven decisions and solving a variety of real-world problems in engineering, computer science or related fields. The course starts with a mathematical and statistical background required for machine learning and covers models, algorithms, and approaches for supervised learning, unsupervised learning,

etc., as well as their applications. This course will also discuss recent advances in data analytics such as data modeling, evaluation, data communication and visualization, and data ethics that are critical to machine learning. Topics covered will be illustrated with MATLAB or other software packages for a range of applications, for example, information process, signal/image processing, pattern recognition, system identification, control, agriculture and farming, and healthcare, etc. Prerequisite(s): ENGE 320 Statistics and Probability for Engineers or equivalent

ENEE 444 Communications System Design Lab (2 credits) Emphasis is placed on laboratory experiments exploring the design and development of communication systems based on topics covered in ENEE 443 Communication Systems. Prerequisite(s): ENEE 443 Communication Systems.

ENEE 452 Artificial Intelligence (3 credits) Introduction to theoretical and computational techniques related to human and machine intelligence, selection of data representations and algorithms useful in the design and implementation of intelligent systems, knowledge representation languages, problem-solving heuristics and machine learning are the focus of this course. Prerequisite(s): ENGE 320 Statistics and Probability for Engineers or Equivalent.

ENEE 372 Computer Networks (3 credits) Fundamentals of computer networks: computer network architecture, network protocols, optical communication, and elements of Queuing Theory. Advance topics in interconnection network architecture and design: network topology, routing strategies, flow control methods, deadlock and deadlock avoidance, congestion control, and network performance analysis. Prerequisite(s): ENGE 250 Digital Logic Design.

ENCE 352 Microprocessor and Microcomputers (3 credits) This course focuses on microprocessor architecture, instruction sets, applications, bus structures, memory, and I/O interfacing. The course also covers assembly language programming, real-time system design, interrupt-driven system design, LSI peripheral configuration and drivers, and embedded-system design. Prerequisite(s): ENGE 250 Digital Logic Design.

ENCE 458 VLSI Design (3 credits) This course focuses on the introduction to the concepts of large-scale integrated circuit design; device fabrication and modeling; designing CMOS combinational and sequential circuits; designing arithmetic building blocks and memory structures; interconnection and timing issues; testing and verification; simulation and use of current CAD tools. Prerequisite(s): ENGE 340 Analog and Digital Electronics.

ENEE 443 Communication Systems (3 credits) This course covers Fourier transforms and linear system analysis; random signals; autocorrelation functions and power spectral densities; analog communication systems; amplitude modulation; single sideband modulation; frequency and phase modulation; sampling theorem and pulse-amplitude modulation; digital communication systems; pulse-code modulation; phase-shift keying; differential phase shift keying; frequency shift keying; performance of analog and digital communication systems in the presence of noise. Prerequisite(s): ENEE 330 Signals and Systems.

ENEE 460 Digital Signal Processing (3 credits) This course is an introduction to digital signal processing; discrete-time description of signals; z-transform; digital filter structures; infinite and finite impulse response filter design techniques. Prerequisite(s): ENEE 330 Signals and Systems.

ENEE 464 Embedded System Design Lab (2 credits) Fundamentals of embedded system hardware and firmware design are the focus of this course. Students will also learn embedded processor selection, hardware/firmware partitioning; architecture and instruction sets of a microcontroller, firmware architecture, design, and debugging, circuit design, layout, and debugging; development tools and a set of design experiments utilizing a popular microcontroller for practical applications. Prerequisite(s): ENGE 383 Control Lab.

ENEE 465 Remote Sensing and Image Processing (3 credits) This course covers passive remote sensing from aerial platforms; basic principles of photogrammetry; geospatial information technology, georeferencing, mosaicking, and rectification; RGB and CIR imagery, multi-spectral imagery; fundamentals of digital image processing; introduction to active remote sensing; applications of remote sensing in engineering and sciences. Prerequisite(s): ENGE 370 Computational Methods in Engineering.

ENCE 454 Computer System Architecture (3 credits) Fundamentals of computer design: cost models, performance models, evaluation methodologies, implementation techniques and tools. Topics include instruction set architectures, pipeline design, memory system design, and basic concepts in storage systems. Understanding the rules of parallelism and power in current and possible future computer designs is a growing component. Prerequisite(s): ENCE 350 Computer Organization.

ENCE 456 Microprocessors Design Lab (2 credits) This course covers hardware designed experiments to provide practical experience in the design, construction, components selection, and interfaces of digital computers and data transmission systems. Prerequisite(s): ENCE 352 Microprocessors and Microcomputers.

ENEE 462 Digital Control System (3 credits) Introduction to techniques for the analysis and design of digital control systems; linearization; difference equations; z-transforms; design of linear controllers; digital implementation of control systems. Prerequisite: ENGE 382 Control Systems.

ENEE 468 Robotics (3 credits) Introduction to industrial manipulator systems; Kinematic and dynamic models of robotic arms; homogeneous transformations; forward and inverse kinematics; motion control through coordinate transformations; robotic vision and sensors. Prerequisite: ENGE 382 Control Systems and ENGE 370 Computational Methods in Engineering

ENEE 469 Robotics and Automation Design Lab (2 credits). This course provides laboratory experiments to design and develop flexible automation systems utilizing robot manipulators based on topics covered in ENEE 468 Robotics course. Prerequisite(s): ENEE 468 Robotics.

ENEE 472 Selected Topics in Engineering (3 credits) Selected topics on special or current topics and issues relating to engineering structured for students in engineering and other areas. Prerequisite: Permission of Instructor

5. **Discuss how general education requirements will be met, if applicable.**

Students in the electrical engineering program will take a total of 39 credits of General Education courses. This includes 28 credit hours of general education courses in English, arts and humanities, social and behavioral sciences, and institution-specific courses, including First-Year Experience, Computer Literacy, and JEDI (Justice, Equity, Diversity, Inclusion). An additional 7 credits in biological and physical sciences and 4 credits in mathematics (Calculus I) are also required for the program. The total number of General Education credits (39) and the composition of the General Education courses meet the requirements of the university General Education program and the engineering program curriculum.

6. **Identify any specialized accreditation or graduate certification requirements for this program and its students.**

As with the current undergraduate General Engineering degree program at UMES, we will seek to have the proposed Electrical Engineering program accredited by the Accreditation Board of Engineering and Technology (ABET). The criteria for accrediting an Electrical Engineering program are stipulated in two areas [Link to ABET Criteria]:

A. **I. General Criteria for Baccalaureate Level Programs, Criteria 5 Curriculum,** and
B. **III. Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs**

Under ABET's **Criteria 5 Curriculum**, "The curriculum must include experience in:

> one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline. Basic sciences are defined as biological, chemical, and physical sciences.
>
> One and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. Engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet these stated needs.

Under ABET's **Program Criteria for Electrical Engineering**, "The curriculum must include:

> probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components.
>
> The curriculum for programs containing the modifier "electrical," "electronic(s)," "communication(s)," or "telecommunication(s)" in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics.

Here we provide an analysis of the proposed credits in each of the categories for the curriculum.

Category		Distribution	Explanation
I.	General Education	39 credit hours	This section includes credits of basic science and math courses, in particular, Chemistry (or Biology), Physics 1/Lab, and Calculus 1.
II.	Supportive Math and Sciences	19 credit hours	This section includes 19 credits in Math and Physics that go beyond those in the Gen Ed section. Per ABET accreditation, 30 credits of science and math are required.
III.	Engineering Core Courses	51 credit hours	This section includes core and major elective courses in the electrical engineering program. Per ABET accreditation, 45 credits for engineering courses are required.
IV.	Elective Courses	11 credit hours	
	TOTAL	**120**	

7. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.

No other institution or non-collegiate organization is required to offer this degree program.

8. Provide assurance and any appropriate evidence that the proposed program will provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.

The entire curriculum and course specific information of the proposed degree program will be posted on the Department of Engineering and Aviation Science website:www.umes.edu/engavi. Information pertaining to the availability of academic/student support services, financial aid resources and tuition payment policies can be found on the webpages of the UMES Office of Admissions and the Office of Financial Aid.

9. Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.

The program will be advertised alongside other academic undergraduate programs within the School of Business and Technology of UMES. Proper venues include Public Radio WESM 91.3, and social media such as UMES Facebook page, the University Key, as well as UMES alumni association, and other professional societies. The Department has a tradition of strong outreach program. For example, the Department has hosted in the past three years the "National Engineer's Week" (in the month of February each year) celebration for high schools from the local counties, such as Wicomico County, Somerset County, etc. Faculty from different disciplines in engineering developed hands-on activities to enable high schools to have firsthand exposure to different engineering disciplines. We will continue this engagement as an effort of advertising, recruiting and promoting engineering education.

H. Adequacy of Articulation

1. **If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.**

This is a new program to be established at UMES's home campus. UMES has existing articulation agreements with community colleges in the state, such as Wor-Wic Community College, as well as with high schools. UMES has an umbrella agreement with Wor-Wic Community College for various B.S. degree programs. We plan to add the proposed BSEE program to this list and have attached the provisional articulation agreement with Wor-Wic to this agreement.

- Culinary Arts AAS to Hospitality and Tourism Management BS
- Business Management AAS to Business Administration BS
- Hospitality Management AAS to Hospitality and Tourism Management BS
- Early Childhood Education AAS to Human Ecology, Child Development BS
- Computer Studies Transfer, Game Development AA to Gaming and Software Engineering BS
- STEM Transfer AS to Construction Engineering and Management BS
- Criminal Justice AAS to Criminal Justice BS
- STEM, Chemistry Pre-Pharmacy AS to Doctor of Pharmacy (PharmD)
- General Studies Transfer AA to Aviation Maintenance Management BS

Furthermore, we have established an agreement with Somerset County Public Schools to align their Project Lead the Way (PLTW) course with the "ENGE 150 Modern Engineering Design" credits, which are part of the BSEE program. That agreement has been attached to this proposal. We will leverage the existing partnerships to develop new articulation agreements, when appropriate, with high schools in the local counties and community colleges for the proposed BSEE program.

I. Adequacy of Faculty Resources (as outlined in COMAR 13B.02.03.11).

1. Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of **faculty with appointment type, terminal degree title and field, academic**

title/rank, status (full-time, part-time, adjunct) and the course(s) each faulty member will teach in the proposed program.

Two (2) new faculty lines in EE have been allocated to support the proposed BSEE degree program by the HBCU settlement fund. Furthermore, the existing faculty in the engineering program will also be able to provide needed expertise to support partially the teaching of courses when necessary. In addition, there are four (4) full-time engineering faculty qualified to teach the EE courses cross-listed in the proposed BSEE curriculum and the existing general engineering curriculum.

Existing four (4) faculty and the two (2) new faculty, all in EE are listed below:

Dr. Yuanwei Jin, Professor and Chair. He received Ph.D. degree in Electrical Engineering from the University of California at Davis. He was with Carnegie Mellon University before joining UMES. His research interests are in the general area of signal processing and sensor array processing, with applications in medical imaging, communications, radar/sonar, and networks.

Dr. Ibibia K. Dabipi, **Professor**. He received his Ph.D. and M.S. in Electrical Engineering from Louisiana State University. His experiences include working at Bell Communications Research and AT&T Bell Labs as a member of technical staff with primary research focus in communications and networks.

Dr. Alvernon Walker, Associate Professor. He received his Ph.D. in Electrical Engineering from North Carolina State University. His primary research area is electronics, digital system design and mixed-signal system design.

Dr. Lei Zhang, Associate Professor. He received his Ph.D. in Electrical Engineering from the University of Nevada, Las Vegas. His primary research area is in computer networks, microprocessor and microcomputers, and embedded system design.

Dr. Liang Zhang, **Assistant Professor** (joined UMES in Fall 2024). He received his Ph.D. degree in Electrical Engineering from New Jersey Institute of Technology. His primary research interests include machine learning, mobile edge computing and airborne networks, wireless communications and UAV communications, wireless virtual reality, caching, and energy optimization.

Dr. Zeenat Afroze, **Assistant Professor** (joined UMES in Fall 2024). She received her Ph.D. degree in Electrical Engineering from the University of South Carolina. Her primary research interests include next generation wireless communications, signal processing, and channel modeling.

To further demonstrate the qualification and the role of the faculty in delivering the instructions of the BSEE program, we list the individual faculty members and the major courses (code with EECE) that align with their expertise:

EE/CE Major or Elective Courses	Dabipi	Walker	Lei Zhang	Liang Zhang	Afroze	Jin
ENEE 330	X			X	X	X
ENEE 348				X	X	X
ENEE 222	X			X	X	X
ENEE 354		X		X	X	
ENEE 301		X			X	
ENEE 462				X	X	X
ENEE 443	X			X		
ENEE 450		X			X	
ENEE 385		X			X	
ENEE 448					X	X
ENEE 387			X	X	X	
ENEE 422				X		X
ENEE 444	X			X	X	
ENEE 452			X	X		
ENEE 372			X	X		
ENCE 350		X	X			
ENCE 458		X	X			
ENEE 460				X	X	X
ENEE 465					X	X
ENEE 464					X	X
ENEE 468			X	X	X	X
ENEE 469			X	X	X	
ENEE 490	X			X	X	
ENCE 454		X	X			
ENCE 465		X	X			
ENCE 352		X	X		X	

2. Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:

a) Pedagogy that meets the needs of the students

b) The learning management system

(a) and (b): Faculty support for the development and instruction of courses is provided by the Center for Teaching Excellence at UMES. The department also supports faculty professional development for attending conferences such as IEEE (Institute of Electrical and Electronics Engineering), ASEE (American Society of Engineering Education) for pedagogy training in engineering education, as well as ABET Symposium for continuous improvement.

Canvas LMS is the current learning management system utilized by UMES throughout the campus. Canvas represents an important development in improving the student experience at UMES, providing valuable new tools for our faculty and supporting students in an impressive digital environment. For faculty, the Center for Instructional Technology & Online Learning (CITOL) https://wwwcp.umes.edu/citol/ supports the development, design, and delivery of online and hybrid programs, classes, and workshops with a focus on flexibility, resiliency, equity, accessibility, privacy, and safety (FREAPS). CITOL assists faculty, staff, and students in all aspects of digital teaching and learning concerning pedagogy and technology. This includes the use of the Canvas Learning Management System, Echo360, Google Workspace, Respondus 4.0, and Respondus LockDown Browser.

c) Evidenced-based best practices for distance education, if distance education is offered.

Not applicable.

J. Adequacy of Library Resources (as outlined in COMAR 13B.02.03.12)**.**

1. **Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program.**

The University assures that institutional library resources meet the new program needs. For the proposed degree program, typically library resources include textbooks, reference books and technical papers. Although UMES does not have the IEEE Xplore Digital Library, the technical papers could be accessed through the Inter-Library Loan (ILL) services.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment (as outlined **in COMAR 13B.02.03.13)**

1. **Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences.**

The UMES department of Engineering and Aviation Sciences is housed in the Engineering and Aviation Science Complex, a 166,000 square feet facility that houses more than 20 engineering laboratories. They include Robotics Lab, Fluid/Thermal lab, Materials lab, Aerospace lab, Electronics Lab, Circuits Lab, Micro-Electro-Mechanical Systems (MEMS) Lab with a Clean Room (ISO Class 5, 6 and 7), Control System Lab, and Embedded System Lab, Communications Lab, Microwave Chamber, CAD/VLSI Lab, High Bay Area, and Multiple Computer Labs, etc. These labs can support majority of the activities in the new courses and research activities. A complete list of engineering labs with brief descriptions is shown by the link:

https://wwwcp.umes.edu/engineering/engineering-laboratories/

All engineering faculty and staff have individual offices that will facilitate student advising, office hours, etc. Sufficient classrooms are available also in the same building, which make it very convenient for students to take classes and conduct laboratory experiments.

2. **Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:**

    a) **An institutional electronic mailing system, and**

    b) **A learning management system that provides the necessary technological support for distance education**

(a) and (b): Faculty support for the development and instruction is provided by the Information Technology Department and the Academic Computing Unit professionals. Consultation is available for issues such as instructional design, software development, and educational research. These technologies and opportunities ensure students enrolled in and faculty teaching have adequate access to leaning resources.

Canvas LMS is the current learning management system utilized by UMES throughout the campus. For faculty, the Center for Instructional Technology & Online Learning (CITOL) https://wwwcp.umes.edu/citol/ supports the development, design, and delivery of online and hybrid programs, classes, and workshops with a focus on flexibility, resiliency, equity, accessibility, privacy, and safety (FREAPS). CITOL assists faculty, staff, and students in all aspects of digital teaching and learning concerning pedagogy and technology. This includes the use of the Canvas Learning Management System, Echo360, Google Workspace, Respondus 4.0, and Respondus LockDown Browser.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

1. **Complete Table 1: Resources and Narrative Rationale. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.**

TABLE 1: RESOURCES					
Resources Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Reallocated Funds[1]	$0.00	$0.00	$0.00	$0.00	$0.00
2. Tuition/Fee Revenue[2] (c+g below)	$139,068.00	$275,400.00	$411,730.00	$548,064.00	$694,396.00
a. # FT Students	15	30	45	60	75
b. # Annual Tuition/Fee Rate	$8,724.00	$8,724.00	$8,724.00	$8,724.00	$8,724.00
c. Annual / Full Time Revenue (a x b)	$130,860.00	$261,720.00	$392,580.00	$523,440.00	$654,300.00
d. # PT Students	3	5	7	9	11
e. Credit Hour Rate	$228.00	$228.00	$228.00	$228.00	$228.00
f. Annual Credit Hours	12	12	12	12	12
g. Total Part Time Revenue (d x e x f)	$8,208.00	$13,680.00	$19,150.00	$24,624.00	$30,096.00
3. Grants, Contracts & Other External Sources[3]	$0.00	$0.00	$0.00	$0.00	$0.00
4. Other Sources	$0.00	$0.00	$0.00	$0.00	$0.00
TOTAL (Add 1 - 4)	$139,068.00	$275,400.00	$411,730.00	$548,064.00	$694,396.00

2. Complete Table 2: Program Expenditures and Narrative Rationale. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each expenditure category.

TABLE 2: EXPENDITURES					
Expenditure Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Total Faculty Expenses (b + c below)	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
2. Total Administrative Staff Expenses (b + c) below	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
3. Total Support Staff Expenses (b + c below)	0	0	0	0	0
a. # FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
4. Equipment	0	0	0	0	0
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	50,000	0	0	0	0
TOTAL (Add 1 - 7)	50,000	0	0	0	0

Narrative Rationale for Table 1: Resources

1. Reallocated Funds
   No funds will be reallocated from existing programs.

2. Tuition and Fee Revenue
   We assume that tuition and fees will remain unchanged for the next five years. The annual in-state tuition rate is $8724 for full time students. For part-time students, the credit hour rate is $228/credit. The two values were used in calculating the revenue for full-time students and 6 credits per semester (i.e., 12 credit per year) for part-time students.

3. Grants and Contracts
   No additional sources of funding are expected currently.

4. Other Sources
   No additional sources of funding are expected currently.

5. Total Year: 5-year estimate is provided.

Narrative Rationale for Table 2: Expenditures

1. Faculty (# FTE, Salary and Benefits)

   No additional faculty lines are requested. Two (2) new full-time tenure-track faculty members in EE joined UMES in Fall 2024. Four (4) existing faculty in EE will jointly support the proposed Bachelor of Science in Electrical Engineering Program.

2. Support Staff (# FTE, Salary and Benefits)
   There will be no need for additional administrative staff. The existing department and school administrative staff will be sufficient to run the program.

3. Equipment
   Not requested.

4. Library
   Minimal funds are needed to purchase additional engineering textbooks.

5. New and/or Renovated Space
   Not needed

6. Other Expenses

M. Adequacy of Provisions for Evaluation of Program (as outlined in COMAR 13B.02.03.15).

1. **Discuss procedures for evaluating courses, faculty and student learning outcomes.**
2. **Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.**

1 and 2:

UMES has a comprehensive course and program evaluation process. Each course syllabus has a set of written student learning outcomes. The course learning outcomes are assessed through embedded questions on tests, assignments and portfolios that address specific course outcomes. Data is collected and analyzed, and results are used to improve course curriculum and pedagogy.

Once the program is launched, its courses will enter the course evaluation system. Teaching evaluations ask students to reflect on the course structure, the course content, and the instructor's performance. Summary data will be reviewed by faculty members, the program chair, and the school administration to determine whether revision or improvement actions are necessary.

In addition, every faculty is evaluated each year. The evaluation process includes an assessment of faculty teaching, faculty research record and productivity, school-wide and department service. To receive a meritorious evaluation, a faculty member must demonstrate effective teaching, active scholarly activities and publication, and service. There is also a provision for administration to develop an improvement plan for faculty members who have not done well in teaching. Tenured faculty will undergo a five-year post-tenure review.

Periodic academic program review takes place in a cycle of every five years. Data regarding program enrollment, retention and graduation rates are collected by the Institutional, Advancement, Marketing, and Research Division in conjunction with the program coordinator. The data are analyzed against program outcomes and results are used to improve the program.

Program accreditation comprehensive review takes place every six years per ABET criteria. The assessment, evaluation, and continuous improvement are integral parts of faculty teaching and performance evaluation.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR 13B.02.03.05).

1. **Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.**

UMES mission is compatible with the State of Maryland's minority achievement goals. UMES is an 1890 land-grant HBCU. Our programs attract a diverse set of students with most of the student

population being African American and those who are multiethnic and multicultural. The University actively recruits minority populations for all undergraduate and graduate level degrees. Special attention is also provided to recruit females into the STEM and multidisciplinary programs at all degree levels – undergraduate, Master's, and doctoral. The same attention will be given to the proposed Bachelor of Science degree program in electrical engineering.

O. Relationship to Low Productivity Programs Identified by the Commission:

1. If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.

The proposed program has no relationship to low productivity programs.

P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)

1. **Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.**
2. **Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.**

Not applicable. The proposed program is not a distance education program.