



May 14, 2026

Elena Quiroz-Livanis
Secretary
Maryland Higher Education Commission
217 E. Redwood Street, Suite 2100,
Baltimore, MD 21202

Dear Secretary Quiroz-Livanis,

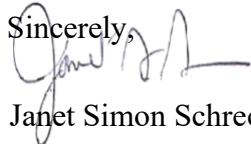
On behalf of Provost Rutkow, I write to request your review and endorsement of the enclosed proposal. The university proposes a new **Master of Science in Energy and Power Systems Engineering**.

The proposed Master of Science in Energy and Power Systems Engineering prepares engineers to meet the growing technical demands of modern energy infrastructure, electrified transportation, and advanced power technologies. The program provides a foundation in energy conversion, power electronics, and electric power systems, offering two academic pathways that align with energy sector career directions.

The proposed program is consistent with the Johns Hopkins mission and the State of Maryland's Plan for Postsecondary Education. The proposal is endorsed by The Johns Hopkins University.

Should you have any questions or need further information, please contact Westley Forsythe at (410) 516-0188 or wforsythe@jhu.edu.

Thank you for your support of Johns Hopkins University.

Sincerely,


Janet Simon Schreck, PhD
Vice Provost for Academic Affairs and Innovation

cc: Dr. Lainie Rutkow

Dr. Westley Forsythe

Enclosures



Office Use Only: PP#

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

Institution Submitting Proposal	The Johns Hopkins University
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Each action below requires a separate proposal and cover sheet.

- | | |
|---|---|
| <input checked="" type="radio"/> New Academic Program | <input type="radio"/> Substantial Change to a Degree Program |
| <input type="radio"/> New Area of Concentration | <input type="radio"/> Substantial Change to an Area of Concentration |
| <input type="radio"/> New Degree Level Approval | <input type="radio"/> Substantial Change to a Certificate Program |
| <input type="radio"/> New Stand-Alone Certificate | <input type="radio"/> Cooperative Degree Program |
| <input type="radio"/> Off Campus Program | <input type="radio"/> Offer Program at Regional Higher Education Center |

Payment <input checked="" type="radio"/> Yes	Payment <input type="radio"/> R*STARS # 12132857	Payment	\$850	Date	05/05/202
Submitted: <input type="radio"/> No	Type: <input checked="" type="radio"/> Check # 12132857	Amount:		Submitted:	

Department Proposing Program	Whiting School of Engineering	
Degree Level and Degree Type	Master of Science	
Title of Proposed Program	Energy and Power Systems Engineering	
Total Number of Credits	30	
Suggested Codes	HEGIS:	CIP: 14.4801
Program Modality	<input type="radio"/> On-campus <input type="radio"/> Distance Education (<i>fully online</i>) <input checked="" type="radio"/> Both	
Program Resources	<input checked="" type="radio"/> Using Existing Resources <input type="radio"/> Requiring New Resources	
Projected Implementation Date	<input checked="" type="radio"/> Fall <input type="radio"/> Spring <input type="radio"/> Summer Year: 2026	
Provide Link to Most Recent Academic Catalog	URL: https://e-catalogue.jhu.edu/	

Preferred Contact for this Proposal	Name:	Westley Forsythe
	Title:	Academic Compliance Officer
	Phone:	(410) 516-0188
	Email:	wforsythe@jhu.edu

President/Chief Executive	Type Name:	Lainie Rutkow
	Signature:	 Date: 05/14/2026

	Date of Approval/Endorsement by Governing Board:
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Revised 1/2021

**The Johns Hopkins University
G.W.C. Whiting School of Engineering
Proposal for a New Academic Program
Master of Science in Energy and Power Systems Engineering**

A. Centrality to Institutional Mission 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 M.S. in Energy and Power Systems Engineering (EPSE) prepares engineers to meet the growing technical demands of modern energy infrastructure, electrified transportation, and advanced power technologies. The program builds a solid foundation in energy conversion, power electronics, and electric power systems while offering two focused academic pathways that align with distinct career directions across the energy sector.

The **Power Electronics and Energy Conversion (PEEC)** track emphasizes the design, control, and implementation of power electronic converters and inverters, electric motor drives, wide-bandgap semiconductor devices, and high-reliability power systems for aerospace, defense, automotive, and emerging electrification applications. This pathway is tailored for students interested in hands-on hardware development and advanced power conversion technologies.

The **Electric Power Systems and Grid Engineering (EPSGE)** track focuses on system-level engineering of electric power networks, including grid planning and protection, power system stability, renewable and storage integration, microgrids, high-voltage DC transmission, market structures, and grid resilience. This option supports students pursuing careers in utilities, transmission and distribution, grid modernization, and large-scale energy systems.

The mission of Johns Hopkins University is to educate students, cultivate lifelong learning, foster independent and original research, and bring the benefits of discovery to the world. The Whiting School of Engineering's mission is to provide educational programs of the highest quality that attract exceptional students and faculty, with a vision to lead in engineering education, knowledge creation, and the translation of research into solutions to pressing technical problems. The proposed Master of Science in EPSE directly advances these aims by delivering rigorous, flexible graduate education for working engineers and by promoting applied research and innovation in power electronics, electric power systems, and renewable integration. The proposed degree program aligns with both the mission of Johns Hopkins University and the mission of the Whiting School of Engineering.

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

A strategic priority of the Whiting School of Engineering is to provide innovative, rigorous, and career-relevant education that prepares graduates to be leaders in their field of expertise. The proposed Master of Science in EPSE advances this priority by addressing urgent needs in energy grid modernization, renewable integration, electrification, and energy resilience. Delivered primarily online, with select hybrid options, the program offers flexible access for working professionals in domestic and international markets while maintaining elevated levels of instruction.

Engineering for Professionals (JHU-EP) has a long record of meeting the lifelong learning needs of practicing engineers through high-quality online programs. EPSE leverages this proven infrastructure to deliver technically rigorous, workplace-applicable instruction in power electronics, electric power systems, integration of renewables and storage, and protection and control. Students complete a common core of four graduate courses drawn from existing ECE offerings directly aligned with energy and power systems, ensuring curricular continuity and efficient use of institutional strengths.

The program reflects an institutional priority through its intentional design and resource alignment. Faculty expertise in power and energy underpins applied coursework and research experiences focused on real-world challenges, with opportunities for collaboration with applied research units. The online-first delivery model is consistent with EP's strategic emphasis on accessibility and scale, enabling professionals to upskill without interrupting their careers while extending the university's reach.

The EPSE program also responds to clear workforce demand from utilities, transportation and electrification, advanced manufacturing, defense and aerospace, and public-sector energy agencies, which are sectors that seek engineers prepared to plan, design, and operate modern energy systems, including transmission, microgrids, storage, protection, stability, and resilience. By equipping graduates to translate discovery into societal benefit, the program advances the missions of Johns Hopkins University and the Whiting School of Engineering and affirms the EPSE program as an institutional priority.

3. Provide a narrative of how the proposed program will be adequately funded for at least the first five years of program implementation

The JHU-EP Program sets aside a portion of its tuition revenue each year as part of its budgeting process to fund the development of new programs and new courses. In addition, the tuition revenue from enrollments in the courses in any program is used to cover the instructional costs of the program before any excess is used for other JHU-EP efforts. If a new program finds that its instructional costs are greater than the tuition revenue, funds are allocated from elsewhere in the overall JHU-EP Program to cover the new program's shortfalls during the first five years. Additional related information is provided in section L.

4. Provide a description of the institution's commitment to:

a. Ongoing administrative, financial, and technical support of the proposed program

The best evidence for the commitment that the JHU-EP Program makes to its students and to their employers to maintain ongoing support for the administrative, financial, and technical support for this program is the history of the JHU-EP Program. Several EP master's degree programs have been in existence for over 50 years, going back to the days of the JHU Evening College. The Whiting School of Engineering greatly values these part-time graduate offerings and the impact that they provide to the engineering community and society. The proposed program would receive the same sort of administrative, financial, and technical support as the other programs in JHU-EP's portfolio.

5. Continuation of the program for a period of time sufficient to allow enrolled students to complete the program

The JHU-EP Program is committed to providing all enrolled students the opportunity to complete the degree program, including under circumstances of low demand. As in the previous section, a historical example is the best evidence for this commitment. In the early 2000s, the part-time undergraduate programs administered by JHU-EP were discontinued after six decades due to a reduction of interest in the programs by both employers and students. After ceasing enrollment of new students, the program developed plans for each remaining student to complete the degree at significant cost to JHU-EP, since many classes needed to be offered with only two or three students attending.

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

JHU-EP is focusing on the “need for advancement and evolution of knowledge” in the state of Maryland with this program. Maryland faces strong and sustained demand for engineers with expertise in electric power systems, power electronics, and grid modernization as the state advances electrification, clean-energy deployment, and infrastructure resilience. State and federal workforce data show that Maryland supports over 93,000 clean-energy jobs, that energy employers report hiring difficulty exceeding 45%, and that electrical engineering occupations are projected to grow by approximately 9% through 2032.

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

The proposed program is well aligned with the 2022 Maryland State Plan for Higher Education. The Master of Science in Energy and Power Systems Engineering is intended to prepare highly-trained engineers to work in organizations where they can contribute to the needs of society. The long-term success of JHU-EP programs for working professionals attests to the quality and effectiveness of these programs.

Candidates can undertake course-related activities at a time and a location most convenient to them from any part of the state of Maryland. The online aspect allows students to participate in and to complete their program with little to no interruption to their work schedule or work arrangements, thus supporting Goal 1, “Student Access: Ensure equitable access to affordable and high-quality postsecondary education for all Maryland residents.”

Similarly, the proposed program is consistent with Goal 2, “Student Success: Promote and implement practices and policies that will ensure student success.” Students in the EPSE program will be supported by the Engineering for Professionals Student Academic Success Office, providing academic support (e.g., tutoring, success webinars, etc.) for those identified as being at risk to drop out.

The proposed program is also consistent with Goal 3, “Innovation: Foster innovation in all aspects of Maryland higher education to improve access and student success.” The remote nature of the coursework and program will grant educational access to working professionals across the State of Maryland who would otherwise not be able to study in-person on a campus.

Lastly, the proposed EPSE program will deliver highly applicable education to power electronics and power systems engineers in the State of Maryland which will improve the workforce outcomes for the State and Maryland residents.

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

Graduates of the EPSE program will be positioned for employment across Maryland’s utility and grid infrastructure, renewable energy and energy storage integration, energy efficiency and building electrification, electrified transportation/EV infrastructure, and defense/aerospace and federal R&D organizations that rely on mission-critical power conversion and distribution. Maryland’s energy economy is already large and growing DOE’s state energy employment analysis reports 93,661 clean energy jobs in Maryland in 2023 and continued year-over-year growth. In addition, the Maryland Energy Administration (MEA) estimates 125,007 energy workers statewide, with 66,570 in energy efficiency, and projects the state will need 22,608 to 64,000 additional energy-efficiency workers over the next 10 years, indicating sustained demand across sectors that require advanced power and energy engineering skills.

Near-term demand is reinforced by employer-reported hiring and growth expectations. In DOE’s state-level data, Maryland energy employers reported 46.3% overall hiring difficulty, and expected growth over the next 12 months of 8.0% in electric power generation and 8.0% in electric power transmission/distribution/storage. These conditions translate into strong opportunities for EPSE graduates in roles such as power systems engineer, grid planning/studies engineer, power electronics engineer, energy storage

integration engineer, microgrid/smart-grid engineer, and electrification engineer.

Maryland's long-term projections indicate steady openings in the core engineering roles that align directly with EPSE training. Projections Central/CareerOneStop report Electrical Engineers in Maryland are projected to grow from 4,400 (2022) to 4,870 (2032) (+9%) with ~290 projected annual job openings. Related roles that commonly support power and energy organizations are projected to grow from 2,050 (2022) to 2,160 (2032) with ~210 projected annual openings. Wage data also indicate these are high-skill, high-wage occupations in Maryland: the Maryland Department of Labor reports 4,400 Electrical Engineers statewide with a mean wage of \$126,270, median wage of \$124,450, and an entry wage of \$84,550. Consistent with JHU EP's working-professional audience, EPSE graduates are expected to enter or advance primarily at the early- to mid-career professional level, with many using the degree to progress into project leadership and mid-level management roles where deep technical breadth across device-level power electronics and system-level grid engineering is required.

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

Maryland's labor-market data indicate strong and sustained demand in the industries and occupations served by the EPSE program. According to the U.S. Department of Energy's 2024 U.S. Energy & Employment Report, Maryland supported 93,661 clean-energy jobs in 2023, with year-over-year growth of approximately 2–2.4%, while energy employers reported 46.3% hiring difficulty and projected ~8% near-term growth in electric power generation and transmission/distribution/storage. At the occupational level, Maryland employs approximately 4,400 electrical engineers, with long-term projections showing ~9% growth through 2032 and hundreds of annual openings driven by both expansion and replacement needs, alongside high median wages (~\$124,000), reflecting persistent demand for advanced skills.

In terms of national demand for a highly-skilled workforce, IEEE Power & Energy Society (IEEE PES) published a 2025 workforce report estimating that the global power sector will need 450,000 to 1.5 million additional power engineers by 2030 because of electrification, renewable integration, grid modernization, and retirements. Further, the U.S. Department of Energy's Energy Workforce Advisory Board reported that 76% of energy employers had difficulty hiring qualified workers.

While labor statistics may indicate that the bachelor's is the lowest degree needed to enter this field, a Master of Science in Energy and Power Systems Engineering is a timely and credible response to a growing workforce demand, especially when designed with strong industry alignment, applied learning, and flexibility for both pre-career and mid-career students. The JHU School of Engineering has been serving working professionals through its continuing and professional education division since 1916. It is not focused on preparing first-time full-time degree graduates with a credential to enter an occupation at an entry-level position but rather responding to professionals' and employers' desire to advance the skills and knowledge of themselves and their human capital, respectively, to remain competitive in their industry.

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

Market-survey evidence indicates both strong employer demand and a constrained talent pipeline in Maryland’s energy and power domains: DOE’s USEER 2024 reports 93,661 clean-energy jobs in Maryland (2023), 46.3% hiring difficulty, and ~8.0% expected near-term growth in both electric power generation and electric power transmission, distribution, and storage. This signals sustained demand for advanced power systems and power-electronics skill sets. Complementing this, the Maryland Energy Administration’s Workforce Needs Assessment (2024) estimates 125,007 energy workers statewide and projects a need for 22,608–64,000 additional energy-efficiency workers over 5-10 years, reinforcing continued vacancies across electrification and grid-modernization work that depends on power and energy engineering competencies.

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

As noted below, the University of Maryland offers a master’s degree focusing on energy systems engineering. As of Fall 2024, there were 13 students in the program. The current and projected supply of graduates in this field is very low in the State of Maryland.

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

JHU houses several engineering degree programs, all with a different focus than that of the proposed degree. The JHU-EP Electrical and Computer Engineering Program focuses on traditional courses in ECE that include communications, networking, computer engineering, electronics, optics, RF, systems, and signal processing. The Whiting School’s Department of Electrical and Computer Engineering offers a residential Master of Science degree that includes courses in AI, speech processing, optoelectronics, microelectronics, image processing, and control systems. In contrast, the proposed EPSE program offers a unique curriculum by integrating device-level power electronics and energy conversion with system-level electric power and grid engineering in a single, fully online, applied graduate program designed for working professionals.

Related graduate degrees offered in the State of Maryland are:

- University of Maryland – MS in Energy Systems Engineering

The University of Maryland’s M.S. program in Energy Systems Engineering and the proposed JHU-EP Energy and Power Systems Engineering program both serve important roles in preparing engineers for careers in the energy sector, but they are designed for

somewhat different student populations and professional objectives. Admission to both programs is based on the academic preparation demonstrated during undergraduate-level training. The University of Maryland program primarily targets students seeking a broad focus in energy systems, whereas the JHU EPSE program is structured to serve engineers seeking application-driven, practice-oriented coursework in power electronics and energy conversion as well as electric power systems and grid engineering, addressing both component-level and system-level aspects of modern energy infrastructure.

Curricularly, the University of Maryland program emphasizes system-level energy engineering, with many courses offered once per year or on a rotating basis and provides students with multidisciplinary exposure through defined elective groupings. The JHU EPSE program, on the other hand, is designed to offer greater scheduling flexibility and curricular breadth, with courses planned to be offered every semester, and a larger portfolio of core and technical electives. All EPSE courses will be delivered fully online, building on JHU EP's established online instructional model, and currently includes 36 courses with plans for continued growth. While both programs aim to prepare engineers for complex challenges in the energy sector, the EPSE program places a distinct emphasis on advanced modeling, analysis, and design of electric power systems and power electronic technologies, reinforced through lab-oriented courses that provide hands-on experience.

The University of Maryland's Mechanical Engineering program offers an excellent set of courses within its Energy and the Environment focus area that are well suited for engineers interested in understanding the relationship between energy systems and their environmental impact. This program provides students with strong technical foundations in energy efficiency, thermal systems, sustainability, emissions reduction, and environmentally conscious engineering design. The UMD Master's degree in Energy and the Environment effectively prepares students seeking careers centered on environmental stewardship, sustainable energy technologies, and energy utilization within buildings and industrial systems.

The JHU EPSE program is intended to complement and expand beyond this type of environmentally focused curriculum by offering a broader and more comprehensive systems-level perspective of the energy and power sector. In addition to environmental and sustainability-related topics, the EPSE program is designed to address the full energy ecosystem, including electric power generation, transmission and distribution, grid modernization, power system operations, energy markets and business considerations. This is categorized in the two focus areas: Power Electronics and Energy Conversion, and Electric Power Systems and Grid Engineering. The program's "device-to-grid" approach is intended to provide students with both the technical depth and multidisciplinary breadth needed to address modern challenges in electrification, resilient power infrastructure, renewable integration, aerospace and defense energy applications, and advanced energy technologies.

2. Provide justification for the proposed program

The Master of Science in Energy and Power Systems Engineering is unique in terms of the content and offering modality. State and federal workforce data consistently identify strong growth and persistent hiring difficulty in electric power systems, grid modernization, power electronics, and electrification, driven by renewable and energy storage integration, transportation electrification, infrastructure resilience, and an aging engineering workforce. While existing programs in Maryland address selected aspects of energy or sustainability, none provide a comprehensive, practice-oriented curriculum that integrates device-level power electronics with system-level grid engineering for working professionals. The EPSE program addresses this gap by delivering advanced, applied education aligned with current and future industry needs, expanding access to specialized technical training, strengthening Maryland's engineering workforce, and supporting statewide priorities in clean energy deployment, infrastructure modernization, and economic competitiveness

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

The EPSE program can support high-demand programs at Maryland's Historically Black Institutions (HBIs) by providing a clear and accessible graduate-level pathway for students who complete bachelor's degrees in electrical and computer engineering or closely related disciplines. HBI graduates seeking to further their education can build on their undergraduate preparation by pursuing advanced, applied training in power electronics, electric power systems, and grid modernization through the EPSE program, which is designed for working professionals and offered fully online. By extending educational and career progression opportunities for HBI graduates, the EPSE program helps strengthen Maryland's engineering talent pipeline, supports retention of skilled professionals within the state, and complements the mission of HBIs in preparing students for high-demand technical fields. The proposed program would not harm the implementation or maintenance of HBI programs in Maryland.

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

An appropriate student for the proposed Master of Science in EPSE would apply after completing a baccalaureate degree at any undergraduate institution, including any of Maryland's Historically Black Institutions. The proposed EPSE program aligns with and reinforces the institutional identities and missions of Maryland's Historically Black Institutions (HBIs) by complementing, rather than duplicating, their academic offerings. HBIs play a critical role in providing high-quality undergraduate education in electrical engineering, computer engineering, engineering technology, and related STEM disciplines, where students gain the foundational knowledge in electronics, circuits, systems engineering, controls, and applied engineering principles. These undergraduate programs are central to the HBIs' missions of expanding access, promoting academic

excellence, and preparing a diverse engineering workforce. The EPSE program builds directly on this foundation by offering an advanced graduate pathway that allows HBI graduates to deepen their technical expertise and specialize in high-demand areas of power electronics, electric power systems, and grid modernization.

The EPSE program has the potential to strengthen HBI undergraduate programs by creating a clear and visible academic and career progression in the energy and power systems field. Students who aspire to careers in power and energy engineering can view HBI undergraduate programs as a strong starting point, with the EPSE program serving as a natural next step for advanced, applied graduate education. This pathway can enhance the attractiveness of HBI programs to prospective students, support retention of talented graduates within Maryland, and reinforce the role of HBIs as essential contributors to the state's engineering workforce pipeline while preserving their distinct institutional missions and educational focus.

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

The proposed EPSE program was established through a deliberate, data-driven planning process to ensure alignment with workforce demand, institutional strengths, and academic quality standards. In 2024, Johns Hopkins Engineering for Professionals (EP) engaged Huron Consulting in a six-month strategic review focused on growth opportunities and new program development. Based on market analyses and industry demand studies, Huron Consulting strongly recommended the launch of a new Power and Energy Systems graduate program. This recommendation prompted focused discussions among EP's Electrical and Computer Engineering program leadership and EP senior leadership, leading to the determination that a newly-developed EPSE program would best serve the needs of working professionals and support strong, sustainable enrollments without adversely impacting existing JHU engineering programs.

The proposed curriculum builds on a substantial portfolio of existing graduate-level EP courses in power electronics, electric power systems, electromagnetics, controls, and related areas, providing a robust launchpad while allowing for the development of new, targeted coursework to support the program's learning outcomes. Oversight of the EPSE program will be provided by qualified Whiting School of Engineering faculty in collaboration with EP program leadership, with additional instructional and advisory contributions from Applied Physics Laboratory professionals, ensuring academic rigor, practical relevance, and continuous alignment with evolving industry needs.

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

Educational Objectives

Within two to five years after graduation, graduates from this program will be able to:

- Advance into roles of increased technical responsibility, such as senior engineer, technical lead, or systems specialist, within utilities, energy technology firms, government agencies, or aerospace/defense organizations.
- Apply advanced engineering knowledge to design, analyze, and integrate power electronics, electric power systems, and energy conversion technologies.
- Utilize rigorous analytical, modeling, and simulation tools to evaluate system performance, reliability, stability, and protection.
- Demonstrate systems-level engineering judgment by evaluating trade-offs among performance, reliability, safety, sustainability, and cost in complex, multidisciplinary power and energy systems.
- Communicate technical information effectively and contribute to leading multidisciplinary teams and supporting project execution.

Student Learning Outcomes

By the end of this program, students will be able to:

- Apply advanced mathematics, science, and engineering principles to analyze electric power systems, power electronics, and energy conversion processes.
- Design power electronic and electric power systems that meet specified performance, reliability, safety, and sustainability constraints.
- Integrate renewable energy, storage, and inverter-based resources into electric power systems while evaluating stability and protection impacts.
- Evaluate engineering trade-offs involving cost, risk, efficiency, reliability, and environmental impact in complex energy systems.
- Communicate technical information clearly and work effectively on multidisciplinary engineering teams.

3. Explain how the institution will:

a. Provide for assessment of student achievement of learning outcomes in the program

During the design of the program's courses, the instructional designers on the JHU-EP staff assist the instructors in preparing learning assessments (assignments, projects, papers, exams, etc.) that are carefully linked to the program's learning outcomes. The instructors then grade these assessments using grading rubrics. The assessment grades indicate the achievement level of each learning outcome.

b. Document student achievement of learning outcomes in the program

The learning assessment scores are retained for the purposes of accreditation and program improvement. Grades are kept in the gradebook in Canvas and in separate learning assessment scorecards that are submitted to the EP Assistant Dean for Teaching and Learning Design at the end of each academic year. If learning outcomes are not met in a given year, the program is expected to change the way the outcome is taught in the related class and then reassessed post adjustment.

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

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

Admission Requirements

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

Prior educational experience must include the following prerequisite courses: Mathematics through vector calculus and differential equations, Calculus-based physics Linear and non-linear circuits, Electromagnetics, Signals and systems. Students' prior education that does not include the prerequisites listed above may enroll under provisional status, followed by full admission once they have completed the missing prerequisites. Missing prerequisites may be completed with JHU-EP. These courses do not count toward the degree requirements. Applicants typically have earned a grade point average of at least 3.0 on a 4.0 scale (B or above) in the latter half of their undergraduate studies. Transcripts from all college studies must be submitted. When reviewing an application, the candidate's academic and professional background will be considered.

Degree Requirements

All courses are three (3) credit hours. To earn a Master of Science in EPSE, 10 courses (30 credits) approved by an advisor must be completed within five years. In addition, all the following must be satisfied:

- Four (4) required core/foundational courses (12 Credits)
 - EN.525.651: Introduction to Electric Power Systems
 - EN.525.725: Power Electronics
 - EN.525.652: Electric Machines and Control for Electrification
 - EN.525.649: Smart Grids
- At least four (4) courses (12 credits) related to energy and power systems from the following list, organized by focus areas:
 - **Power Electronics and Energy Conversion**
 - EN.525.605: Intermediate Electromagnetics
 - EN.525.609: Continuous Control Systems
 - EN.525.614: Probability & Stochastic Processes for Engineers
 - EN.525.617: Computation for Engineers
 - EN.525.620: Electromagnetic Transmission Systems
 - EN.525.623: Principles of RF and Microwave Circuits
 - EN.525.624: Analog Electronic Circuit Design

- EN.525.629: Discrete-Time Control Systems
 - EN.525.661: UAV Systems and Control
 - EN.525.726: Applications of Power Electronics Design
 - EN.525.727: Advanced Power Electronics
 - EN.525.738: Advanced Antenna Systems
 - EN.525.764: Nonlinear Controls
 - EN.525.771: Propagation of Radio Waves in the Atmosphere
 - EN.525.774: RF & Microwave Circuits I
 - EN.525.775: RF & Microwave Circuits II
 - EN.525.788: Power Microwave Monolithic Integrated Circuit Design
 - EN.525.790: RF Power Amplifier Design Techniques
 - EN.615.642: Electromagnetics
 - EN.615.762: Applied Computational Electromagnetics
 - **Electric Power Systems and Grid Engineering**
 - EN.525.649: Smart Grids
 - EN.525.653: Power System Control, Optimization, Grid Management
 - EN.525.777: Control System Design Methods
 - EN.535.652: Thermal Systems Design and Analysis
 - EN.535.662: Energy and Environment
 - EN.545.672: Green Engineering, Alternative Energy and CO2 Capture/Sequestration
 - EN.565.686: Sustainable Coastal Engineering
 - EN.565.734: Wind Engineering
 - EN.575.723: Environmental Sustainability and Next Generation Buildings
 - EN.575.732: Energy Technologies for Solving Environmental Challenges
 - EN.575.734: Smart Growth Strategies for Sustainable Cities
 - EN.575.733: Energy and Environment
 - EN.695.634: Intelligent Vehicles: Cybersecurity for Connected and Autonomous Vehicles
- The remaining two courses may be chosen from the list above or from other relevant programs within Engineering for Professionals.
 - A minimum of four (4) courses must be at the 700-level.
 - Students are not required to take all courses from a specific focus area. The focus areas are a collection of courses organized into a specific technical field.
 - Students have the option of taking one or two independent study courses, **or** two thesis courses that explore technical areas beyond the course offerings. Independent study and thesis courses count as 700-level courses.
 - Only one (1) C-range (+/-) grade may be counted toward the master's degree.

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

Not applicable.

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

Not applicable.

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

Not applicable.

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

All specific course-related information (e.g., course requirements, nature of faculty/student interaction, assumptions about technology competence and skills, and technical equipment requirements) is provided in the syllabus for each course and is available on the Canvas course site. Program-related information (e.g., degree requirements, learning management system information, availability of academic support services, financial aid resources, and tuition payment policies) can be found both on the JHU-EP website (<http://ep.jhu.edu>) and as well as in the Engineering for Professionals Academic Catalog (<https://ep.jhu.edu/student-services/academic-services/academic-catalogs/>).

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 JHU-EP website (<http://ep.jhu.edu>) contains the same marketing, recruiting and admission materials that are used in print or other forms and made available to the students. The JHU-EP academic catalog, which is available on the website, also contains the same material. We affirm that these materials represent a good faith effort to be totally clear and transparent in all our communications with current and new students. Incidentally, the need for clear and accurate program descriptions is also critical to the employers who are a very important factor in supporting our students in their academic pursuits.

H. Adequacy of Articulation

Not applicable.

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 faculty member will teach (in this program)

See Appendix B for a representative list of faculty who will teach in the proposed program. The program has identified highly-qualified faculty members. Each is a distinguished and experienced professional, and all have advanced degrees (MS, DSc, or PhD) in their fields of expertise. Each has demonstrated a strong commitment to excellence in teaching. Most are practicing engineers or scientists at the JHU Applied Physics Laboratory as well as faculty and researchers from the Whiting School of Engineering, or other local universities, corporations, or government, and many hold influential positions in their organizations. The JHU-EP program provides engineering education rooted in practice by relying heavily on practitioner faculty members.

2. Demonstrate how the institution will provide ongoing pedagogy training for the faculty in evidenced-based best practices, including training in a. Pedagogy that meets the needs of the students, b. The learning management system and c. Evidenced-based best practices for distance education if distance education is offered

Faculty support for the development of online courses is provided by JHU-EP's Center for Teaching and Learning Design (CTLTD) consisting of 18 instructional designers and course support specialists as well as JHU-EP's Center for Media and Technology Solutions (CMTS), consisting of 9 multimedia technicians and instructional technologists. Faculty have multiple opportunities to receive training on the Canvas learning management system, and in the pedagogy of online learning. These opportunities are presented at various times throughout the year at events such as fall/spring annual faculty meetings, training webinars, and privately scheduled training sessions. Once an instructor has been identified to develop an online course, they are given access to a set of web-based resources that cover a broad range of topics on online pedagogy, use of instructional technologies and learning management system tutorials. Throughout the online course development, the instructor receives direct support and guidance from their assigned instructional designer, as well as from the instructional technology and multimedia staff. This could take the form of course design guidance based on best practices in online learning, course production support, and audio and video recording support. Once the course is built, the support staff continues to help the faculty member, offering best practices in course instruction and help desk support. After the course runs, these teams help the instructor make updates and improvements to the course.

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

Students have access to the Milton S. Eisenhower Library on the Homewood campus, which is ranked as one of the nation's foremost facilities for research and scholarship. Its collection of more than three million bound volumes, several million microfilms, and more than 13,000 journal subscriptions has been assembled to support the academic efforts of the University. The interlibrary loan department makes the research collection of the nation available to faculty and students. The library also provides easy access to a wide selection of electronic

information resources, including the library's online catalog, and numerous electronic abstracting and indexing tools. Many databases are accessible remotely. Librarians help students electronically, and the library maintains an extensive web site to take visitors through all its services and materials. More than 10,000 audiovisual titles are added for on-site consultation.

K. Adequacy of Physical Facilities, Infrastructure, and Instructional Equipment (as outlined in COMAR13B.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. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs**

All required courses in the proposed program will be offered online (with in-person hybrid options for some courses). The program will have no discernible impact on the use of existing facilities and equipment beyond the standard requirements already in place. See additional details in section K.2 below.

- 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) All JHU students receive an Office 365 account including email capabilities (built on Outlook Live), as well as 25GB of online storage, and collaboration, blogging, photo-sharing, event-planning, instant messaging, and other tools. The email account is accessible from a variety of browsers on both the PC and Mac, including full support for Edge, Firefox, Google Chrome, and Safari.
 - b) All JHU students enrolled in EPSE program courses that include hardware laboratory components will receive a laboratory kit shipped to them from JHU at the start of the semester. These kits are provided to students at no additional cost and include a pre-paid return package to facilitate the return of the equipment at the conclusion of the semester for reuse in future semesters.
 - c) This program will be delivered via JHU-EP's online programs infrastructure, which includes the Canvas course management system and the Zoom video conferencing system. These technologies are supported by the Whiting School and the university's IT infrastructure and provide password-protected online course sites and community management systems that enable ongoing collaborative exchange and provide convenient channels for synchronous and asynchronous learning. Canvas is one of the world's leading providers of e-learning systems for higher education institutions. This software focuses on educational outcomes and provides a highly flexible learning

environment for students. Johns Hopkins is also outfitted with suitable technical and professional staff and a help desk to provide technical assistance to the students taking online courses. All the student services such as application processes, course registration, bookstore, ID service, and advising are currently provided online as well.

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

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

Please see Appendix C.

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

Once the EPSE program is launched, its courses enter the course evaluation system. Students in all JHU-EP courses receive two evaluations each term; one after the first half and one at the end of the term. These evaluations ask students to reflect on the course structure, course content, and the instructor's performance. Summary reports are reviewed by the faculty member, the program chair, and the JHU-EP administration to determine whether changes are necessary. The Program Committee will discuss these results as well to consider the broader context of the program's curriculum and course delivery mechanisms.

As described in section G.3, student learning outcomes are carefully and deliberately linked to in-class learning assessments (assignments, projects, papers, exams, etc.) throughout the curriculum. The instructors then grade these assessments using grading rubrics. The assessment grades indicate the achievement level of each learning outcome. If learning outcomes are not met in a given year, the program is expected to change the way the outcome is taught in the related class and then reassess post adjustment.

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.

Procedures for evaluating student satisfaction, instructor effectiveness, and student learning outcomes are mentioned in sections G.3 and M.1. The data that the program chair and program committee will need to evaluate performance and develop action plans where deficiencies are identified will be provided by the JHU-EP administrative staff. Student retention will be monitored by the JHU-EP institutional research staff and reported to JHU-EP leadership. Faculty satisfaction will be monitored by the individual EP program chairs through frequent informal communication, and at least once per year

during a formal program-wide faculty meeting. The cost-effectiveness of the program will be monitored by the JHU-EP finance team and reported to JHU-EP leadership.

N. Consistency with the State’s Minority Student Achievement Goals (as outlined in COMAR13B.02.03.05).

Any student meeting the admissions requirements can apply to the Master of Science in Energy and Power Systems Engineering. The program will work to help all accepted students improve their workplace competitiveness and reach their professional goals; an aim consistent with the State’s minority student achievement goals.

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

Not applicable.

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.

JHU-EP has decades of experience administering successful online graduate programs. The EPSE program will be supported in the same way as the other twenty-five online master’s degree programs at the Whiting School of Engineering.

2. Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program

a) Online learning is appropriate to the institution’s mission and purposes

The mission of Johns Hopkins University is to educate its students and cultivate their capacity for life-long learning, to foster independent and original research, and to bring the benefits of discovery to the world. More simply stated, it is “Knowledge for the world.” An online delivery format is not just appropriate, but truly a critical requirement of disseminating knowledge to students who are unable to travel to the Baltimore campus.

The institution’s plans for developing, sustaining, and, if appropriate, expanding online learning offerings are integrated into its regular planning and evaluation processes

JHU-EP has fully embraced online education, to the extent that when a new program is developed, it is fully expected that the program will be delivered through an online modality. This includes hardware lab kits that are mailed to remote students. This part-time online division now reports up to the Whiting School of Engineering’s Vice Dean for Graduate Education and Lifelong Learning, who also oversees all full-time residential graduate programs. As such, online education has increased exposure to Whiting School of Engineering leadership and is included in long-term planning,

including student and faculty support systems. There is a clear vision for JHU-EP's online education enrollment growth documented in the program's five-year budget plan.

b) Online learning is incorporated into the institution's systems of governance and academic oversight

Johns Hopkins University reviews new online program proposals using the same systems of governance and academic oversight as that for new on-site programs. Before being shared with the deans of all JHU academic divisions, all proposals must first undergo a review by internal academic bodies, including discussions of fit with School mission, program viability, program rigor, instructor quality, and redundancy with existing programs. For Whiting School of Engineering programs, this entails a review by the Whiting School Graduate Committee, a faculty body with representation from both the part-time online and full-time residential program faculty. If approved, a proposal is then forwarded to the Homewood Academic Council for review by faculty from both the Whiting School of Engineering and the Krieger School of Arts and Sciences. As discussed in M.1, once a program is launched, its courses will enter the course evaluation system. Students in all JHU-EP courses receive two evaluations each term -- one after the first half and one at the end of the term. These evaluations ask students to reflect on the course structure, course content, and the instructor's performance. Summary reports are reviewed by the faculty member, the program chair, and the JHU-EP administration to determine whether changes are necessary. The Program Committee will discuss these results as well to consider the broader context of the program's curriculum and course delivery mechanisms. Lastly, JHU-EP, and all the programs that it offers, undergoes a rigorous review by the Homewood Academic Council faculty every five years.

c) Curricula for the institution's online learning offerings are coherent, cohesive, and comparable in academic rigor to programs offered in traditional instructional formats

In some cases, a JHU-EP program's asynchronous online courses are first developed and run as synchronous courses (either on-site or online), and this provides a suitable benchmark for course rigor and workload. A formal online course development process is then used to support the development of all online courses. This process incorporates the Quality Matters™ research-based set of eight standards for quality online course design that help to ensure the academic rigor of the online course is comparable to or better than the traditionally offered course. A JHU-EP program is composed of courses that are appropriately sequenced to ensure students have adequate background for courses later in the program. Courses are offered frequently enough to ensure that students can complete a degree program within the 5-year maximum allowable timeframe. All JHU-EP courses have a maximum of 19 student enrollees so that students have adequate access to the instructor. Courses are built with components such as discussion boards to facilitate student-student and student-faculty interaction. Courses that are traditionally best taught using hardware

laboratory components will continue to incorporate these elements. A proven delivery model will be used to provide each student with the required laboratory equipment, ensuring a consistent and effective hands-on learning experience.

d) The institution evaluates the effectiveness of its online learning offerings, including the extent to which the online learning goals are achieved, and uses the results of its evaluations to enhance the attainment of the goals

As discussed in M.1, once a program is launched, its courses will enter the course evaluation system. Students in all JHU-EP courses receive two evaluations each term -- one after the first half and one at the end of the term. These evaluations ask students to reflect on the course structure, course content, and the instructor's performance. Summary reports are reviewed by the faculty member, the program chair, and the JHU-EP administration to determine whether changes are necessary. The Program Committee will discuss these results as well to consider the broader context of the program's curriculum and course delivery mechanisms.

As discussed in G.3, during the design of the program's courses, the instructional designers on the JHU-EP staff assist the instructors in preparing learning assessments (assignments, projects, papers, exams, etc.) that are carefully linked to the program's learning outcomes. The instructors then grade these assessments using grading rubrics. The assessment grades indicate the achievement level of each learning outcome. The learning assessment scores are retained for the purposes of accreditation and program improvement. Grades are kept in the gradebook in Canvas and in separate learning assessment scorecards that are submitted to the EP Associate Vice Dean at the end of each academic year. If learning outcomes are not met in a given year, the program is expected to change the way the outcome is taught in the related class and then reassess post adjustment.

e) Faculty responsible for delivering the online learning curricula and evaluating the students' success in achieving the online learning goals are appropriately qualified and effectively supported

Any new instructor recruited to teach online must have a graduate degree in a relevant field, and they must have professional experience related to the course content. Each prospective instructor is interviewed by the program leadership to assess their teaching abilities in an online modality. Faculty support for the development of online courses is provided by JHU-EP's Center for Teaching and Learning Design (CTLD) consisting of 18 instructional designers and course support specialists as well as JHU-EP's Center for Media and Technology Solutions (CMTS), consisting of 9 multimedia technicians and instructional technologists. Faculty have multiple opportunities to receive training on the Canvas learning management system, and in the pedagogy of online learning. These opportunities are presented at various times throughout the year at events such as fall/spring annual faculty meetings, training webinars, and privately scheduled training sessions. Once an instructor has been identified to develop an online course, they are given access to a set of web-based

resources that cover a broad range of topics on online pedagogy, use of instructional technologies, and learning management system tutorials. They are also paired with a seasoned program instructor in a mentor–mentee relationship, providing an additional faculty resource with expertise in a closely related technical field. Throughout the online course development, the instructor receives direct support and guidance from their assigned instructional designer, as well as from the instructional technology and multimedia staff. This could take the form of course design guidance based on best practices in online learning, course production support, or audio and video recording support. Once the course is built, the support staff continues to help the faculty member, offering best practices in course instruction and help desk support. After the course runs, these teams help the instructor make updates and improvements to the course.

f) The institution provides effective student and academic services to support students enrolled in online learning offerings

JHU-EP maintains numerous web-based resources to inform prospective students of the information they may need as an online student. These resources include: JHU-EP main website (<http://ep.jhu.edu>) and the JHU-EP online catalog (<https://ep.jhu.edu/student-services/academic-services/academic-catalogs/>), which both include detailed programmatic information, academic support services, financial aid, costs, policies, etc. and specific information for online learning. As new online students are admitted, they are introduced to the JHU-EP program and procedures through the fully online New Student Orientation, that includes information on registration, student advising, ordering textbooks, the JHU email system, and other online student services. All students who enroll in an online course are also enrolled in the New Online Student Orientation module, which focuses on introducing students to techniques that will enable them to be successful in an online course and trains them on the Canvas learning management system. Lastly, all new students are enrolled in a mandatory Academic Integrity training course -- a zero-credit, zero-tuition course that is geared towards helping students avoid behaviors linked to plagiarism, cheating, and other violations of academic integrity.

Students are assigned an academic advisor when accepted. New students receive a personalized welcome email from their assigned academic advisor that directs them to useful links specific to the program. Students can work individually with the advisor to develop a course of study that meets the requirements of the program and the career goals of the student. Courses that deviate from the program plan and have not been approved by an academic advisor may not count toward degree requirements. All advising can be received remotely.

Students have online access to the Milton S. Eisenhower Library on the Homewood campus, ranked as one of the nation's foremost facilities for research and scholarship. The interlibrary loan department allows students access to resources at any other university in the nation. The library also provides easy access to a wide selection of electronic information resources, including the library's online catalog, and numerous

electronic abstracting and indexing tools. Many databases are accessible remotely. Librarians are available to assist students remotely, and the library maintains an extensive website to take visitors through all its services and materials.

John's Hopkins University is committed to making all academic programs, support services, and facilities accessible to qualified individuals with disabilities. Students with disabilities who require reasonable accommodations can contact the JHU-EP Disability Services Administrator and receive support remotely.

Student Health and Wellbeing cultivates and supports holistic well-being for individuals, relationships, groups, and the Hopkins community across all schools and divisions. Stress, personal problems, family conflict, and life challenges can affect the academic progress of students. Student Health and Wellbeing focuses on problem solving through short-term counseling. Online students may call a phone number for consultation and will be directed to the appropriate resource or office. All services are completely confidential. The program operates under State and Federal confidentiality legislation and is HIPAA compliant.

g) The institution provides sufficient resources to support and, if appropriate, expand its online learning offerings

The JHU-EP program prepares a five-year budget every year that includes sufficient resources to maintain all online programs and expand offerings, if desired. The budget contains funding for marketing and recruitment for all programs as well as staffing all programs in terms of admissions services, students and faculty support services, finance and administration services, and instructional design and instructional technology services. Funding for hardware lab kits is provided to each program as part of the learning resources for lab-oriented courses. The budget also contains funding for new program viability analyses, new program marketing launches, and new course development costs. Faculty and staff development costs are included, as described in greater detail in section P.2.f above.

The JHU-EP Program collaborates with central Johns Hopkins University Information Technology to provide a robust and scalable, but also flexible, technical infrastructure that serves student and faculty member needs. These programs are delivered via JHU-EP's online programs infrastructure, which includes the Canvas course management system and the Zoom video conferencing system. These systems provide password-protected online course sites and community management systems that enable ongoing collaborative exchange and provide convenient channels for synchronous and asynchronous learning.

h) The institution assures the integrity of its online offerings

The Higher Education Opportunity Act (HEOA) enacted in 2008 requires that an academic institution that offers distance education opportunities to students: (1) has a process established to verify that the student who registers is the same student who participates in and completes the offering and receives academic credit for it, (2) has

a process established to verify that student privacy rights are protected, and (3) has a process established that notifies the student about any additional costs or charges that are associated with verification of student identity. In JHU-EP programs, the following actions have been taken to satisfy these requirements: (1) students may only enter the academic website for the online courses they take by providing the unique student ID and password assigned after admission, (2) all FERPA privacy rights are preserved by limiting access very specifically in the University student information system to only those permitted by law to have access to restricted student information, and (3) there are no additional costs assessed to the student for the measures we use to verify student identity.

Other measures are taken as well to ensure the integrity of JHU-EP online offerings. The Whiting School of Engineering's Graduate Academic Misconduct Policy applies to all JHU-EP online students, it clearly defines misconduct, and it includes references to the most common online student infractions. As referenced in section P.2.g, all new JHU-EP students are enrolled in a mandatory Academic Integrity training course -- a zero-credit, zero-tuition course that is geared towards helping students avoid behaviors linked to plagiarism, cheating, and other violations of academic integrity. Lastly, JHU-EP has recently required that all essay-based coursework be submitted to SafeAssign, a Canvas integrated tool used to prevent plagiarism by identifying unoriginal content and creating opportunities to help students identify how to properly attribute sources rather than paraphrase.

Appendix A – Course List

Course Descriptions

EN.525.620

Electromagnetic Transmission Systems

This course examines transmission systems used to control the propagation of electromagnetic traveling waves with principal focus emphasizing microwave and millimeter-wave applications. The course reviews standard transmission line systems together with Maxwell's equations and uses them to establish basic system concepts such as reflection coefficient, characteristic impedance, input impedance, impedance matching, and standing wave ratio. Specific structures are analyzed and described in terms of these basic concepts, including coaxial, rectangular, and circular waveguides, surface waveguides, striplines, microstrips, coplanar waveguides, slotlines, and finlines. Actual transmission circuits are characterized using the concepts and analytical tools developed.

EN.525.649

Smart Grids

This course provides a comprehensive introduction to the principles, technologies, and applications of Smart Grids, with a particular emphasis on renewable and sustainable energy integration. Students will examine the design, control, and optimization of decentralized power generation systems. Key topics include energy storage systems, grid interconnection, power system optimization, demand-side management, Microgrid design and operation, and advanced smart grid technologies. The course also incorporates case studies of distributed generation projects to assess their impacts on grid stability, sustainability, and community energy resilience.

EN.525.651

Introduction to Electric Power Systems

This course introduces and explains fundamentals of electrical power systems design and engineering. Phasors and their application to power systems analysis are reviewed. The concept of the per-unit system is introduced and applied to circuit calculations. Transformers and their application to electrical power transmission and distribution systems will be covered.

Transmission line parameters, their calculation, and transmission line modeling are introduced. Steady-state operation of transmission lines is modeled and investigated. Power flow analysis computational techniques are covered. Short-circuit analysis and the method of symmetrical components are introduced. The concept of power system protection and the role of automatic relays will be covered. Primary and secondary distribution systems and substations are introduced. Renewable energy generation and the integration of renewable energy into the modern power grid will be introduced. Prerequisite(s): Course in electrical networks and a course in linear algebra and matrix operations. MATLAB required software. Course Note(s): Matlab is required for this course.

EN.525.725

Power Electronics

This course is designed to provide students a solid foundation on the fundamentals and principles of power electronics. Analytical modeling and control techniques will be introduced in addition to practical design considerations for switching regulators. Topics include steady state analysis, large and small signal modeling, control loop design, input filter and magnetic design, along with switch realization and efficiency evaluation. Advanced topics such as soft switching and active power factor correction will also be introduced. Each topic will include an in-class modeling and simulation component, utilizing MATLAB/ Simulink, to reinforce concepts and provide the student with a practical design tool for evaluating compliance with typical performance requirements.

EN.525.726

Applications of Power Electronics Design

This course presents applications and practical considerations for the design of power electronic circuits, building on the fundamentals and principles covered in 525.725 Power Electronics. We will go through the step-by-step design and modeling of a synchronous buck converter including the power stage, small-signal model, controller, full simulation, component selection, and magnetics design. Additional topics covered include circuit board layout, peak current mode control, and practical methods of addressing common challenges in power supply circuits. Students gain hands-on experience through lab-based assignments and a design project. All required test equipment will be provided. Students are expected to have basic soldering skills and experience with electronic test equipment (DC power supplies, oscilloscopes, multimeters).

EN.525.727

Advanced Power Electronics

This course extends the fundamental concepts learned during the Power Electronics course by examining advanced power electronics applications. Applications include solar array peak power tracking, dc motor control, three phase electric drive and control, converter soft switching techniques, power factor correction and nonlinear control techniques for optimum dynamic converter performance. Working knowledge of MATLAB's Simulink is required to demonstrate, through simulation, concepts learned during each module.

EN.525.605

Intermediate Electromagnetics

This course provides a background in engineering electromagnetics required for more advanced courses in the field. Topics include vector calculus, Poisson's and Laplace's equations, Vector potentials, Green's functions, magnetostatics, magnetic and dielectric materials, Maxwell's equations, plane wave propagation and polarization, reflection and refraction at a plane boundary, frequency-dependent susceptibility functions, transmission lines, waveguides, and simple antennas. Practical examples are used throughout the course.

EN.525.609

Continuous Control Systems

This course closely examines classical methods of representation, analysis, and design of continuous control systems, and introduces state-space representation, analysis and design

techniques. Topics include dynamic system representation by linear time invariant ordinary differential equations, state-space representation of linear time-invariant systems, block diagrams and signal flow graphs, performance measures, sensitivity, stability, root locus analysis, frequency domain analysis, similarity transformations, controllability, and control design methods. Some practical examples are considered. MATLAB is used as a computational tool. Prerequisite(s): Background in linear algebra and linear differential equations.

EN.525.614

Probability & Stochastic Processes for Engineers

This course provides a foundation in the theory and applications of probability and stochastic processes and an understanding of the mathematical techniques relating to random processes in the areas of signal processing, detection, estimation, and communication. Topics include the axioms of probability, random variables, and distribution functions; functions and sequences of random variables; stochastic processes; and representations of random processes. Prerequisite(s): A working knowledge of multi-variable calculus, Fourier transforms, and linear systems theory.

EN.525.617

Computation for Engineers

Designing algorithms in a finite precision environment that are accurate, fast, and memory efficient is a challenge that many engineers must face. This course will provide students with the tools they need to meet this challenge. Topics include floating point arithmetic, rounding and discretization errors, problem conditioning, algorithm stability, solving systems of linear equations and least-squares problems, exploiting matrix structure, interpolation, finding zeros and minima of functions, computing Fourier transforms, derivatives, and integrals. Matlab is the computing platform.

EN.525.623

Principles of RF and Microwave Circuits

This course addresses foundational microwave circuit concepts and engineering fundamentals. Topics include electromagnetics leading to wave propagation and generation, the transmission line, and impedance/admittance transformation and matching. Mapping and transformation are presented in the development of the Smith Chart. The Smith Chart is used to perform passive microwave circuit design. Microwave networks and s-matrix are presented; Mason's rules is introduced. Circuits are physically designed using microstrip concepts, taking into consideration materials properties, connectors, and other components.

EN.525.624

Analog Electronic Circuit Design

This course examines the use of passive and active components to perform practical electronic functions. Simple circuits are designed and evaluated emphasizing the characteristics and tolerances of actual components. Devices studied include diodes and bipolar and field effect transistors. Circuit designs are studied in relation to the device characteristics, including small signal amplifiers and oscillators, and linear power supply and amplifier circuits. SPICE modeling is available to students. Prerequisite(s): Undergraduate courses in electricity and magnetism, circuit theory, and linear analysis.

EN.525.629

Discrete-Time Control Systems

This course presents a comprehensive introduction to the theory and design of discrete-time control systems. Representation, modeling, and analysis of discrete-time / sampled-data systems are first studied. Then, the design of discrete-time control systems is introduced using both digital design emulation methods (e.g., emulating a continuous-time compensator via zero-pole mapping, hold equivalents, etc.) and direct design (transform) methods using root locus and frequency domain synthesis techniques (e.g., Bode, Nyquist). The “classical” approach to discrete-time control system representation, analysis and synthesis is followed by a discussion of the “modern” approach which includes discrete-time state-space representation of dynamic systems, controllability, observability, similarity transforms, and pole placement via full state feedback methods. Sample rate selection and the effects of quantization are also discussed. As part of this course, the student will research and select (with instructor approval) a conference / journal article or textbook section / chapter discussing an applications-based discrete-time control system concept and / or design process in an area of particular interest to the student. The paper / article should reflect and emphasize one or more of the key topics introduced in this course. The student reviews the paper, implements the concept(s), and develops a final presentation video to be shared with the class. MATLAB will be used in this course for all design and analysis topics; therefore, it is expected that students taking the course have familiarity with MATLAB functional and programming fundamentals.

EN.525.649

Smart Grids

This course provides a comprehensive introduction to the principles, technologies, and applications of Smart Grids, with a particular emphasis on renewable and sustainable energy integration. Students will examine the design, control, and optimization of decentralized power generation systems. Key topics include energy storage systems, grid interconnection, power system optimization, demand-side management, Microgrid design and operation, and advanced smart grid technologies. The course also incorporates case studies of distributed generation projects to assess their impacts on grid stability, sustainability, and community energy resilience.

EN.525.652

Electric Machines and Control for Electrification

This course prepares the student for technical understanding of the principles and theory of operation of electric motors and motor controls commonly used for electrification. Various types of electric motors including permanent magnet and synchronous reluctance motors and control schemes are covered in this class. The class addresses key performance metrics in electric motor design and construction. Mobile inverter configuration is covered. The course extensively discusses advanced motor control concepts, and their applications for electrification. We use Simulink & Simscape throughout the course. Lab sessions may be integrated as well.

EN.525.653

Power System Control, Optimization, and Grid Management

This course explores the advanced principles and techniques used in the control, optimization, and management of modern power systems. The course provides an in-depth understanding of key concepts in power system control, including voltage and frequency regulation, load flow

analysis, and stability assessment. Students will also study optimization techniques used in power system operation, such as economic dispatch, unit commitment, and optimal power flow (OPF), to minimize costs and improve system efficiency. Throughout the course, students will develop the skills needed to apply optimization and control methods to real-world power system problems.

EN.525.661

UAV Systems and Control

This hardware-supplemented course covers the guidance, navigation- and control principles common to many small fixed-wing and multirotor unmanned aerial vehicles (UAVs). Building on classical control systems and modeling theory, students will learn how to mathematically model UAV flight characteristics and sensors, develop and tune feedback control autopilot algorithms to enable stable flight control, and fuse sensor measurements using extended Kalman filter techniques to estimate the UAV position and orientation. Students will realize these concepts through both simulation and interaction with actual UAV hardware. Throughout the course, students will build a full 6-degree-of-freedom simulation of controlled UAV flight using MATLAB and Simulink. Furthermore, students will reinforce their UAV flight control knowledge by experimenting with tuning and flying actual open-source quadrotor UAVs.

Prerequisite(s): Background in control systems (e.g., EN.525.609 Continuous Control Systems) and matrix theory along with a working knowledge of MATLAB. Experience using Simulink is desired. Existing familiarity with C programming language, electronics, and microcontrollers will be helpful but is not required.

EN.525.738

Advanced Antenna Systems

This course is designed to follow 525.618 Antenna Systems. Advanced techniques needed to analyze antenna systems are studied in detail. Fourier transforms are reviewed and applied to antenna theory and array distributions. The method of moments is studied and used to solve basic integral equations employing different basis functions. Green's functions for patch antennas are formulated in terms of Sommerfeld-like integrals. Techniques such as saddle-point integration are presented. Topics addressed include computational electromagnetics, Leaky and surface waves, mutual coupling, and Floquet modes. Students should be familiar with complex variables (contour integration), Fourier transforms, and electromagnetics from undergraduate studies.

EN.525.764

Nonlinear Controls

This course covers the fundamentals of the design of controllers for nonlinear dynamic systems. Topics include Lyapunov Theory, Describing Functions, Feedback Linearization, Sliding Mode Control, as well as several Adaptive Control Techniques. The course will provide the theoretical background necessary to design and analyze nonlinear controllers while grounding the theory with practical, physical applications.

EN.525.771

Propagation of Radio Waves in the Atmosphere

This course examines various propagation phenomena that influence transmission of radio frequency signals between two locations on earth and between satellite-earth terminals, with a

focus on applications. Frequencies above 30 MHz are considered with emphasis on microwave and millimeter propagation. Topics include free space transmission, propagation, and reception; effects on waves traversing the ionosphere; and attenuation due to atmospheric gases, rain, and clouds. Brightness temperature concepts are discussed, and thermal noise introduced into the receiver system from receiver hardware and from atmospheric contributions are examined. Also described are reflection and diffraction effects by land terrain and ocean, multipath propagation, tropospheric refraction, propagation via surface and elevated ducts, scatter from fluctuations of the refractive index, and scattering due to rain. Atmospheric dynamics that contribute to the various types of propagation conditions in the troposphere are described. Prerequisite(s): An undergraduate degree in electrical engineering or equivalent.

EN.525.774

RF & Microwave Circuits I

In this course, students examine RF and microwave circuits appropriate for wireless communications and radar sensing. The course emphasizes the theoretical and experimental aspects of micro-strip design of highly integrated systems. Computer-aided design techniques are introduced and used for the analysis and design of circuits. Circuits are designed, fabricated, and tested, providing a technically stimulating environment in which to understand the foundational principles of circuit development. Couplers, modulators, mixers, and calibrated measurements techniques are also covered.

EN.525.775

RF & Microwave Circuits II

This course builds upon the knowledge gained in 525.774 RF and Microwave Circuits I. Here there is a greater emphasis on designs involving active components. Linear and power amplifiers and oscillators are considered, as well as stability, gain, and their associated design circles. The course uses computer-aided design techniques and students fabricate and test circuits of their own design.

EN.525.777

Control System Design Methods

This course examines advanced multivariable control system design methodologies and how the available techniques are applied to produce practical system designs. Both the underlying theories and the use of Matlab to synthesize and analyze feedback designs are covered. We start with control problem formulations that capture performance and stability robustness objectives in the face of system parameter uncertainties and unknown disturbances. Specific design techniques include the linear quadratic regulator, the linear quadratic gaussian regulator with loop transfer recovery, H-infinity design, and mu-synthesis. Nonlinear techniques such as sliding mode control and feedback linearization are introduced as well as adaptive control methods that apply supervised learning while ensuring stability via Lyapunov analysis. Weekly assignments will include graded homework problems and Matlab exercises to practice the covered design and analysis methods.

EN.525.788

Power Microwave Monolithic Integrated Circuit (MMIC) Design

This course covers additional circuit design techniques applicable to MMICs (and microwave circuits in general). It is an extension of EN.525.774/

RF and Microwave Circuits I and II and EN.525.787 Microwave Monolithic Integrated Circuit (MMIC) Design, although for students with a microwave background, these particular courses are not prerequisites. The topics covered include broadband matching, optimum loads for efficiency and low intermodulation products, odd mode oscillations, details of nonlinear modeling, time domain simulation of nonlinear circuits, and thermal effects. Students do need to have a background in microwave measurements and microwave CAD tools. No project is required, but there is structured homework involving power MMIC design completed by the student using a foundry library.

EN.525.790

RF Power Amplifier Design Techniques

This course addresses foundational power amplifier circuit concepts and engineering fundamentals. The design of high power/high efficiency amplifiers that satisfy specific system requirements (bandwidth, linearity, spectral mask, etc.) are covered. Various device technologies (GaAs, GaN, LDMOS, SiGe), device scaling and modeling, optimum load calculations, amplifier classes (A, B, AB, C, E, F, etc.), waveform engineering, modulation techniques, efficiency enhancement, odd/even mode stability analysis, linearization techniques, power combining, reliability, lifetime calculation, and packaging are studied. The concepts are explored theoretically, and practically using numerous design exercises. This course stresses hands-on design techniques and practical considerations for real-world situations and applications.

EN.695.634

Intelligent Vehicles: Cybersecurity for Connected and Autonomous Vehicles

New technologies within the automotive industry are fusing the physical, digital, and biological worlds to create intelligent vehicles that are designed to enhance occupants' experiences and improve driver safety and efficiency and improve pedestrian safety. The success of these commercial and industrial efforts rest in the principles of assured autonomy. These intelligent technologies exist in a connected ecosystem that includes the Transportation, Energy, and Communication sectors. Examples of the interconnectivity capabilities include: Autonomous Vehicle – transducer, interface, and supporting capabilities; Electric Vehicles – grid connected vehicle charging infrastructure; and Vehicle-to-Vehicle and Vehicle-to-Everything Communication Technologies. This course helps students understand the significance of assured autonomy safety and functional correctness of intelligent vehicles throughout the technology's lifecycle. This course follows a seminar format where students are expected to lead class discussions and write a final report as part of a course project. The course project will teach experimental design and the scientific method. The outcome of the project will be a proposal that, if executed, could result in a workshop-quality publication. Execution of the proposed experiment is encouraged but not required for the class. Proposals will be graded by both the instructor and by classmates. This course is oriented around helping students learn how to make a compelling research contribution to the area of intelligent vehicles and assured autonomy. Students will also learn to critique scientific papers in this research area by reading articles from the literature and analyzing at least one paper in order to lead a class discussion. Prerequisites: This course is suitable for graduate students with little prior experience in the area.

EN.615.642

Electromagnetics

Maxwell's equations are derived and applied to the study of topics including electrostatics, magnetostatics, propagation of electromagnetic waves in vacuum and matter, antennas, wave guides and cavities, microwave networks, electromagnetic waves in plasmas, and electric and magnetic properties of materials. Prerequisite(s): Knowledge of vector analysis, partial differential equations, Fourier analysis, and intermediate electromagnetics.

EN.535.652

Thermal Systems Design and Analysis

Thermodynamics, fluid mechanics, and heat transfer principles are applied using a systems perspective to enable students to analyze and understand how interactions between components of piping, power, refrigeration, and thermal management systems affect the performance of the entire system. Following an overview of the fundamental principles involved in thermal and systems analyses, the course will cover mathematical methods needed to analyze the systems and will then explore optimization approaches that can be used to improve designs and operations of the thermal systems to minimize, for example, energy consumption or operating costs. Students are expected to perform basic computer programming in a language chosen by the student (e.g., Matlab, Python, etc). Example Matlab code to complement the course content will be provided by the instructor. Prerequisite(s): Undergraduate courses in thermodynamics and heat transfer.

EN.535.662

Energy and Environment

The course focuses on the impacts of energy consumption and generation on the environment. Second law thermodynamic analysis will be used to help understand the quality of different energy sources and to assess whether they are being used to their fullest abilities. Given the attention given to climate change, greenhouse gas emissions from the energy sector will be evaluated. Life Cycle Assessment will be introduced to help understand broader environmental impacts from the acquisition of raw materials to the disposal of devices and equipment. The course will examine the key places where energy is used in the economy (buildings, industry, transportation) then transition to key sources of energy and issues in generation of energy (utilities, nuclear energy, alternative energy, energy storage, water-energy nexus).

EN.545.672Green Engineering, Alternative Energy and CO₂ Capture/Sequestration

This course inherently combines green engineering, alternative energy and CO₂ capture and storage into a concentrated semester lecture. Green Engineering applies the cost-effective design, commercialization, and use of chemical processes in ways that minimize pollution at the source, and reduce impact on human activities and the environment. After general discussion of applying environmental principles into various chemical processes, this course will switch the gear to apply these green engineering ideas into the energy production that has increasing and critical importance to our modern world, how to minimize the pollution and CO₂ emission. There are two ways to follow: 1. Alternative Energy, which uses alternative resources rather than the current dominant fossil fuel for energy production. Alternative energy includes solar, hydro, bioenergy, geothermal, tidal, nuclear energy and et al. The detailed production processes, the long term perspective, policy and advantages/disadvantages over their counterpart, fossil fuel,

will be discussed. 2. Fossil fuel with CO₂ Capture and Storage. CO₂ capture methods such as chemical solvents/chemical looping, membrane, oxy fuel combustion will be discussed and their technical benefits/limitations will be studied. The storage will cover geological methods (coal bed and saline aquifer), enhanced oil recovery, ocean storage, terrestrial and others. The technical details, cost, future trends and national/international policy (carbon taxes/markets) will be discussed in this course.

EN.615.762

Applied Computational Electromagnetics

This course introduces the numerical methods and computer tools required for the practical applications of the electromagnetic concepts covered in EN.615.642 to daily-life engineering problems. It covers the methods of calculating electromagnetic scattering from complex air and sea targets (aircraft, missiles, ships, etc.), taking into account the effects of the intervening atmosphere and natural surfaces such as the sea surface and terrain. These methods have direct applications in the areas of radar imaging, communications, and remote sensing. Methods for modeling and calculating long-distance propagation over terrain and in urban areas, which find application in the areas of radar imaging, radio and TV broadcasting, and cellular communications, are also discussed. The numerical toolkit built in this course includes the method of moments, the finite difference frequency and time domain methods, the finite element method, marching numerical methods, iterative methods, and the shooting and bouncing ray method. Prerequisite(s): Knowledge of vector analysis, partial differential equations, Fourier analysis, basic electromagnetics, and a scientific computer language.

EN.565.686

Sustainable Coastal Engineering

This course presents a review of sustainable engineering related to the ocean environment. Sustainable shore protection designs will be investigated such as living shorelines and sills, beach nourishment, and other sustainable methods in order to adapt to coastal hazards such as hurricanes, tsunamis, and sea level rise. Sustainable energy such as coastal wind energy, wave energy, tidal energy, and other sustainable energy sources will be also investigated as alternative energy designs. The importance of sustainable food production will be discussed and aquaculture system designs such as ocean aquaculture, shellfish aquaculture, and other sustainable food production will be studied.

EN.565.734

Wind Engineering

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

EN.575.723

Environmental Sustainability and Next Generation Buildings

The course will introduce the concepts, applications, and tools for analysis and decision making in support of sustainable environmental development and next-generation communities and building design. Students will be introduced to a variety of challenges related to environmental protection, stewardship, and management of air, soil, and water. The underlying principles of ecological protection, stewardship, reduced environmental footprint, ecosystem capital, sustainable economic development, and globalization impacts will be reviewed. The integration of actions that are ecologically viable, economically feasible, and socially desirable to achieve sustainable solutions will be evaluated. Within this context, the course will explore sustainable building concepts that are intended to provide, throughout their lifetime, a beneficial impact on their occupants and their surrounding environment. Such buildings are optimally integrated on all parameters-initial affordability, timeliness of completion, net life-cycle cost, durability, functionality for programs and persons, health, safety, accessibility, aesthetic and urban design, maintainability, energy efficiency, and environmental sustainability. The principles of LEED building design and certification will also be introduced with a review of example projects. Integrated design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants will be assessed in the broad areas of (1) sustainable site planning, (2) safeguarding water and water efficiency, (3) energy efficiency and renewable energy, (4) conservation of materials and resources, and (5) indoor environmental quality. Also, a further critical element being addressed for a successful sustainable building policy and program is an integrated building planning and design process.

EN.575.732

Energy Technologies for Solving Environmental Challenges

This course covers the science, engineering, and operation of energy technologies – on a stand-alone and systems basis – that will reduce carbon dioxide and other greenhouse gas (GHG) emissions, and lower air pollution, with quantitative analysis where applicable. On the supply side, students will learn about solar radiation and its use for solar photovoltaic (PV) technologies (at a cell, module, and system-level) and concentrated solar power (CSP) with thermal storage, and other renewable energy technologies that use wind, water, and biomass, as well as the use of carbon capture and sequestration (CCS). Energy storage technologies covered to support variable renewable energy (VRE) integration include lithium-ion and other types of batteries, pumped hydro, compressed air energy storage (CAES), and longer-term energy storage from the production of hydrogen, using electrolysis and other low carbon methods. End-use energy technologies covered will include battery electric vehicles (BEV), plug-in hybrid (PHEV) and fuel cell electric vehicles (FCEV), and some examples of the use of low carbon heat sources or feedstocks for industrial processes and combined heat and power (CHP).

EN.575.733

Energy and the Environment

This course examines the interrelationships between the environment and the ways in which energy is produced, distributed, and used. Worldwide energy use patterns and projections are reviewed. Particular attention is paid to the electrical and transportation sectors of energy use. Underlying scientific principles are studied to provide a basis for understanding the inevitable environmental consequences of energy use. Topics studied include fossil, nuclear, and existing and potential renewable sources, including hydroelectric, geothermal, tidal, wind, and solar. Transportation options including internal combustion, hybrid, and electric options are

quantitatively compared. Use of alternate fuels such as biodiesel and ethanol are evaluated. Emphasis is placed on the environmental impacts of energy sources, including local effects resulting from emissions of nitrogen oxides, sulfur, hydrocarbons, and particulates as well as global effects such as mercury release from coal combustion. Carbon emissions are a continuing theme as each energy technology is studied and its contribution to climate change is assessed. Carbon suppression schemes are examined. Particular attention is paid to consequences and effectiveness of government intervention and regulation. The purpose is to help students understand how energy is converted into useful forms, how this conversion impacts our environment, and how public policy can shape these impacts.

EN.575.734

Smart Growth Strategies for Sustainable Cities

This course addresses the concepts, practices, and tools for smart environmentally sustainable green city planning and provides an understanding of how to apply these principles to communities. The development of environmentally green cities is a pattern of using resources to meet human needs today while preserving the environment so that these needs can also be met by future generations. The course addresses many environmental design concepts for smart environmental growth and sustainable green development, including balanced land use planning principles; importance of an overall transportation strategy; providing urban tree coverage; leveraging public transportation accessibility; providing a spectrum of housing availability; integration of office, retail, and housing units; reduction of environmental footprint; use of recycled, reused, green, and sustainable products; integration of renewable solar energy and wind power into buildings and government systems; transit-oriented development; innovative low-impact storm water management practices; reduction in urban heat island effects; urban water resource management; and energy efficiency and conservation. The course has been completely redeveloped and includes five case studies of green development projects.

EN.615.731

Photovoltaic & Solar Thermal Energy Conversion

This is an advanced course in the application of science and technology to the field of solar energy in general and photovoltaic and solar thermal energy systems in particular. The foundations of solar energy are described in detail to provide the student with the knowledge to evaluate and/or design complete solar thermal or photovoltaic energy systems. Topics range from the theoretical physical basics of solar radiation to the advanced design of both photovoltaic and solar thermal energy collectors. A major feature of the course is the understanding and design of semiconducting photovoltaic devices (solar cells). Solar cell topics include semiconductors, analysis of p-n junction, Shockley-Queisser limit, non-radiative recombination processes, antireflection coating, crystalline silicon solar cells, thin-film solar cells, and rechargeable batteries. Solar thermal energy topics include solar heat collectors, solar water heaters, solar power systems, sensible heat energy storage, phase transition thermal storage, etc. The course will also present optimizing building designs for a solar energy system.

Prerequisite(s): An undergraduate degree in engineering, physics, or a related technical discipline.

Appendix B

Energy and Power Systems Engineering Faculty

Faculty Member	Highest Degree Earned	Degree Field	Employer	Status at JHU	ENG School Title	Classes Taught
Hedy Alavi	PhD	Civil Engineering	Johns Hopkins University	FT	Lecturer	EN.575.732, EN.575.733
Raid Awadallah	PhD	Electrical and Computer Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.615.642, EN.615.762, EN.615.731
Amit Banerjee	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.614, EN.525.651, EN.525.624
Jeffrey Barton	MS	Applied and Computational Mathematics	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.661
Thomas Byrd	JD	Corporate Law	T. Rowe Price	PT	Lecturer	EN.695.634
Ali Darwish	PhD	Electrical Engineering	U.S. Army Research Laboratory	PT	Lecturer	EN.525.623, EN.525.788, EN.525.790
Lawrence DiGirolamo	MS	Aerospace Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.661
G. Daniel Dockery	MS	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.771
Keith Dupree	PhD	Mechanical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.764, EN.525.777
William Healy	PhD	Mechanical Engineering	TRC Companies	PT	Lecturer	EN.535.652, EN.535.662
Olusesan Iwarere	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.614
Hasan Mehrjerdi	PhD	Electrical Engineering	George Washington University	PT	Lecturer	EN.525.649, EN.525.653
Sarah Mouring	PhD	Civil Engineering	US Naval Academy	PT	Lecturer	EN.565.686
Suresh Natarajan	PhD	Electrical Engineering	Johns Hopkins University	PT	Lecturer	EN.525.652
Neil Palumbo	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.609, EN.525.629
Alan Pue	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.777, EN.525.788

Michael Purcell	PhD	Applied Physics	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.605
Juan Ramirez	MS	Electrical and Computer Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.726
John Reichl	PhD	Electrical Engineering	Johns Hopkins University	PT	Lecturer	EN.525.725, EN.525.727
William Roper	PhD	Environmental Engineering	John Hopkins University	PT	Lecturer	EN.575.723, EN.575.734
Hermann Brian Sequeira	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.620
Haya Shajaiah	PhD	Electrical Engineering	The George Washington University	PT	Lecturer	EN.525.614, EN.525.617
Avinash Sharma	PhD	Electrical Engineering	JHU Applied Physics Laboratory	FT	Lecturer	EN.525.774, EN.525.775
Sue-Jane Wang	PhD	Biostatistics	U.S. Food and Drug Administration	PT	Lecturer	EN.545.672
Steven Weiss	DSc	Electrophysics	Johns Hopkins University	PT	Lecturer	EN.525.738
Donghun Yao	PhD	Civil Engineering	NIST	PT	Lecturer	EN.565.734

APPENDIX C

Table 1: Program Resources

RESOURCES	2026-27	2027-28	2028-29	2029-30	2030-31
1. Reallocated Funds	\$0	\$0	\$0	\$0	\$0
2. Tuition/Fee Revenue (c + g below)	\$366,925	\$379,600	\$471,262	\$568,814	\$894,400
a. Number of F/T Students	0	0	0	0	0
b. Annual Tuition/Fee Rate	NA	NA	NA	NA	NA
c. Total F/T Revenue (a x b)	\$0	\$0	\$0	\$0	\$0
d. Number of P/T Student Enrollments	65	65	78	91	104
e. Credit Hour Rate	\$1,882	\$1,947	\$2,014	\$2,084	\$2,150
f. Credits Per Course	3	3	3	3	4
g. Total P/T Revenue (d x e x f)	\$366,925	\$379,600	\$471,262	\$568,814	\$894,400
3. Grants, Contracts & Other Ext Sources	\$0	\$0	\$0	\$0	\$0
4. Other Sources	\$0	\$0	\$0	\$0	\$0
TOTAL (Add 1 – 4)	\$366,925	\$379,600	\$471,262	\$568,814	\$894,400

Resources Narrative

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

Table 2: Program Expenditures

EXPENDITURES	2026-27	2027-28	2028-29	2029-30	2030-31
1. Faculty (b + c below)	\$88,570	\$90,341	\$119,024	\$134,459	\$150,464
a. # FTE	1.2	1.2	1.5	1.7	1.8
b. Total Salary	\$82,009	\$83,649	\$110,208	\$124,499	\$139,318
c. Total Benefits	\$6,561	\$6,692	\$8,817	\$9,960	\$11,145
2. Admin. Staff (b + c below)	\$47,886	\$49,592	\$51,360	\$53,193	\$55,093
a. # FTE	0.75	0.75	0.75	0.75	1.75
b. Total Salary	\$45,553	\$47,169	\$48,844	\$50,579	\$52,378
c. Total Benefits	\$2,333	\$2,423	\$2,516	\$2,613	\$2,714
3. Support Staff (b + c below)	\$25,351	\$26,238	\$40,735	\$42,160	\$43,636
a. # FTE	0.25	0.25	0.375	0.375	0.375
b. Total Salary	\$18,848	\$19,508	\$30,286	\$31,346	\$32,443
c. Total Benefits	\$6,503	\$6,730	\$10,449	\$10,814	\$11,193
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	\$103,438	\$106,541	\$131,685	\$158,241	\$186,272
TOTAL (Add 1 – 7)	\$265,245	\$272,712	\$342,803	\$388,053	\$435,465

Expenditures Narrative

1. Faculty: The Engineering for Professionals lecturers are paid \$10,152 (for 2025-2026) per course taught and \$11,166 per course developed. These were used as base rates. For years 1 – 5, an additional 2% was added to the salary rate. The fringe rate is estimated at 8%.
2. Administrative Staff: Includes salary for Program Chair and advisors.
3. Support Staff: Includes pro-rated salaries for F/T Instructional Designers, Instructional Technologists and Multimedia Technicians to assist in developing online courses.
4. Equipment: No direct equipment costs are identified.
5. Library: Existing library facilities are sufficient to meet the needs of the program.
6. New or Renovated Space: No new or renovated space will be needed.
7. Other Expenses: Indirect program costs plus direct expenses associated with the Program Chair (conferences, travel, task support) are provided here.