

EN.645 (SYSTEMS ENGINEERING)

EN.645.621. Engineering and Measuring Influence. 3 Credits.

Systems engineering requires an understanding of how people interact with complex systems. Often times, human interaction makes up a substantial portion of system variance and controlling this variance is critical for system performance. Engineers must design interventions to influence people through all aspects of the system. Emerging technology can be used to understand, measure, and assess the effectiveness of interventions to influence human behavior and performance. This course will introduce students to theories of behavior change and provide hands on experience using technologies to measure human-system interaction and influence. Technologies will include biometric, psycho-physiological, and neuroimaging systems.

EN.645.631. Introduction to Model Based Systems Engineering. 3 Credits.

The Introduction to Model Based Systems Engineering course provides an overview of what Model Based Systems Engineering (MBSE) is and how MBSE techniques can be applied to the Systems Engineering process to manage complexity, reduce risk, and potentially streamline the engineering design and development effort. Students will utilize an industry-leading system modeling tool and develop artifacts applied to real-world case studies that reinforce the MBSE concepts of methodology, language, and tools.

Prerequisite(s): EN.645.662

EN.645.632. Applied Analytics for Model Based Systems Engineering. 3 Credits.

This course is a continuation of Introduction to Model Based Systems Engineering (MBSE), and provides in-depth exposure to building and using industry-leading system modeling tools to apply and analyze real-world case studies. This course will focus on the application of Model Based Systems Engineering through the use of a modeling language, a modeling method and a system modeling tool as part of the systems engineering process to support requirements, design, analysis, specification, and verification and validation activities of the system. Concepts that were developed from the previous course are now analyzed to assist the systems engineer to explore the solution space using MBSE.

Prerequisite(s): EN.645.631 Introduction to Model Based Systems Engineering.

EN.645.650. Foundations of Human Systems Engineering. 3 Credits.

Systems are designed, built, and used by humans. Their purpose is to help people meet their goals and perform their tasks. This course introduces the foundations of HSE from which system requirements and design elements are derived. The objective is to provide students with the knowledge of human capabilities and introduce human systems engineering concepts and design principles. Human capabilities include visual, auditory, and touch senses, motion, cognitive processing, and decision making. Human systems engineering concepts and design principles include human factors engineering; training; maintenance; environmental, safety, and health; survivability; habitability; manpower; and personnel. **Prerequisite(s):** Admission into the Systems Engineering program.

EN.645.651. Integrating Humans and Technology. 3 Credits.

This class provides a hands-on introduction to human and cognitive systems engineering. Students will learn and apply user-centered research and innovation methods that are used to discover, document and integrate human capabilities, limitations and needs into the systems engineering process, improving the likelihood that the resulting systems are intuitive, efficient, effective and useful. Topics include needs elicitation, workflow analysis, functional allocation, decision making, prototyping, and performance measurement.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering OR EN.655.662 Introduction to Healthcare Systems Engineering OR EN.675.600 Systems Engineering for Space

EN.645.662. Introduction to Systems Engineering. 3 Credits.

This course introduces students to the fundamental principles of systems engineering and their application to the development of complex systems. It describes how the systems engineering viewpoint can be brought to bear to address engineering challenges as well as the essential role of systems engineering in project management. Topics include defining systems, the system development life cycle, and the systems engineering method. These primary topics are decomposed into requirements analysis, functional design, physical design, design validation, concept development, engineering development, and post development. In addition, the tools and methods at the systems engineer's disposal are also covered. These include risk analysis, configuration management, design trade-offs, modeling and simulation, and interface management, as well as how these subjects are linked to systems program management activities. More advanced Systems Engineering topics such as Software Systems, System of Systems, Enterprise Systems, and Agile Systems Engineering are introduced. The course defines the breadth and depth of the knowledge that the systems engineer must acquire concerning the characteristics of the diverse components that constitute the total system. Students will work as a group to develop and present a conceptual system architecture chosen from a list of existing systems in order to gain familiarity with architecting, system modeling, and the relationship between requirements, activities, hardware/software, interfaces, and other system elements. **Course prerequisite(s):** Admission into the Systems Engineering program.

EN.645.667. Management of Systems Projects. 3 Credits.

The course addresses the management of a technical project from concept to operational use, with emphasis on the functions, roles, and responsibilities of the project manager. From the development of a proposal to the delivery of a product to a customer, the efforts to conceive, plan, budget, schedule, monitor, control/direct, and report the progress of the project are discussed. Throughout the project life cycle, the need for good communications, interface and configuration management, and conflict resolution is emphasized. Students assume the role of project managers who must use management tools such as WBS, EVM, and CPN and who must address typical problems that arise in the conduct of a high-technology systems project. **Prerequisite(s):** Admission into the Systems Engineering program.

EN.645.669. Systems Engineering of Deployed Systems. 3 Credits.

Systems engineering theory typically focuses on the early design and development phases of a system's life cycle, yet over the life of a system, the bulk of engineering effort and the associated costs are not realized until the operations and support (O&S) phase. This course will examine the importance of designing O&S considerations early in a system's life cycle by identifying the appropriate logistic elements and measures, while introducing the necessary analytical processes and tools to support end-to-end life cycle engineering requirements. Manufacturing and production operations will be presented along with the elements that support a system once it is fielded (maintenance planning, reliability prediction, supply support, training, shipping, and system disposal). The course will also explore the requirements and processes associated with major upgrades to deployed systems and the logistics management techniques that must be implemented during initial fielding and deployment. A class project and real-world case studies will underscore the theory and techniques associated with deployed systems engineering.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering or EN.645.667 Management of Systems Projects. College-level Statistics (College-level Calculus preferred but not required).

EN.645.711. Systems Engineering of Missile Technologies. 3 Credits.

This course emphasizes the key systems engineering processes involved in missile design. Missile technologies including electro-optical and radio-frequency sensors used for target detection; aerodynamics; navigation, guidance, and control; propulsion; warheads; fuzes; and signal and image processing are discussed in conjunction with the critical tradeoffs and methods used to meet operational requirements. The course objectives are demonstrated through a system cost-as-an-independent variable trade and design study that is based on trades of sensor type, guidance type, operational constraints and implementation, and how the system is segregated into different sub-system configurations.

EN.645.742. Management of Complex Systems. 3 Credits.

Traditional systems engineering is usually applied to closed, precise, and recursive systems with the assertion that the methodologies used can be scaled up to more elaborate systems of systems. This course addresses the more realistic and emerging field of complex systems, where multiple current development efforts with disparate and nonlinear attributes characterize the system components. Managing complex systems must account for the likelihood of multiple disciplines, differing scales, often unpredictable future states, irreducible uncertainty, and nonlinear behavior. Customers, corporations, governments, technologies, and systems now must be considered on a global scale with a mix of new and legacy systems. The student will be encouraged to think differently and creatively about the approaches to managing complex systems and to use adaptive strategies and tools. Special attention will be given to risk assessment and management for dynamic systems. Case studies and examples will be drawn from commercial industry and DoD/government systems. Students will be expected to discuss several readings and complete academic papers to explore in depth one or more of the concepts discussed.

Prerequisite(s): EN.645.769 System Test and Evaluation or advisor and instructor approval. Course Note(s): Selected as one of the electives in the Master of Science in Engineering or Master of Science program or a required course for the post-master's certificate.

EN.645.753. Enterprise Systems Engineering. 3 Credits.

Enterprise systems engineering is a multidisciplinary approach combining systems engineering and strategic management to address methods and approaches for aligning system architectures with enterprise business rules and the underlying IT architecture; development and implementation consistent with enterprise strategic objectives; and the total enterprise system and capabilities, with diverse complex subsystems. This course uses the systems engineering life cycle as a framework for linking outcome-based engineering analysis and decision making with enterprise strategic objectives, addressing methods and tools for managing complexity, determining measures of effectiveness, and assessing return on investment from an engineering perspective. The complex nature of enterprises will be discussed, including the multiplicity of technical and business components involved in delivering enterprise capability, as well as methods for modeling and analysis of their interdependence. Business and technical interdependencies among infrastructure, computing, applications, services, and end-user environments will be discussed. Particular attention will be paid to outcome-based management, understanding total cost of ownership for delivered capabilities, and end-to-end systems engineering.

Prerequisite(s): EN.645.769 System Test and Evaluation or advisor and instructor approval. Course Note(s): Selected as one of the electives in the Master of Science in Engineering or Master of Science program or a required course for the post-master's certificate.

EN.645.754. Social and Organizational Factors in Human Systems Engineering. 3 Credits.

The objective of this course is to provide students with the knowledge of organizational structure, social interaction, and group behavior needed to reflect the full context of use in the practice of systems engineering. It examines the characteristics of organizations and of social contexts that influence system requirements and design and describes systems engineering processes for discovering, representing, and analyzing such information in practice. It covers the application of these factors throughout the system life cycle. Topics covered include groupware, social networks, organizational change, organizational culture, high reliability organizations, leadership, and engineering ethics.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering.

EN.645.755. Methods in Human-System Performance Measurement and Analysis. 3 Credits.

This course focuses on human-systems performance measurement (HsPM) methods used to determine whether human-system requirements are met and if the system's design provides effective and efficient human-system performance. Students will gain knowledge of HsPM study design protocols, data collection tools and methods, analysis techniques and processes, and procedures required to execute studies with human participants. The course will provide students with an understanding of HsPM in the context of system design; workplace design; environment, safety, and occupational health; training; and maintenance. Students will be exposed to heuristic evaluations; modeling and simulation of human tasking, including tools for measuring physical limitations, cognitive load, and fatigue; and system testing with the human element.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering.

EN.645.756. Metrics, Modeling, and Simulation for Systems Engineering. 3 Credits.

This course takes an integrated, in-depth view of foundational statistical concepts, modeling, and simulation techniques. Knowledge of typical system-level key performance parameters and their stochastic characterization is critical to the systems engineering process as the basis for decision-making from early system conceptualization through retirement. Relevant probability and statistics concepts are covered in context of SE decision points. Techniques in experimental design, data collection, analysis, and modeling of system metrics as a function of system use and environment are explored as they pertain to characterizing system, subsystem, and component performance. Finally, implementing models in analytic simulations to support requirements, design, upgrade, and replacement/retirement phases of the SE process provides the systems engineer with a solid foundation for making and justifying difficult decisions.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering, EN.645.667 Management of Systems Projects, and EN.645.767 System Conceptual Design.

EN.645.757. Foundations of Modeling and Simulation in Systems Engineering. 3 Credits.

This course provides an introduction to the field of modeling and simulation (M&S) from the perspective of M&S as an essential tool for systems engineering. The course presents an overview of the M&S discipline, the model/simulation development process, the types of models and simulations used in the various phases of the systems engineering life cycle, and the verification, validation, and accreditation of models and simulation. The strengths and limitations of M&S are explored with respect to the application of M&S use in systems engineering. Examples are given for several types of systems, including both military and civilian systems. Statistical methods used in applying M&S in systems engineering are explained. The Arena process modeling tool is used for some examples, an individual assignment, and a team-based project. Upon completion of the course, the student will be able to explain when M&S will provide meaningful support to a technical program, select the appropriate modeling techniques for a given task, plan the development of a model/simulation and the modeling of its input data, and analyze the results of its execution to support decisions at key milestones of a system's life cycle.

Prerequisite(s): EN.645.662 (462) Introduction to Systems Engineering

EN.645.758. Advanced Systems Modeling and Simulation. 3 Credits.

This course is a continuation of EN.645.757 Foundations of Modeling and Simulation in Systems Engineering and provides in-depth exposure to the field of modeling and simulation (M&S) from the perspective of M&S as an essential tool for systems engineering. Advanced statistical methods are used to conduct requirements-driven simulation analysis and experimentation. The course provides treatment of advanced M&S topics, including verification, validation, and accreditation techniques; methods for simulation interoperability and composability; modeling of the system environment, both natural and man-made; modeling of system costs; and the establishment of collaborative M&S environments. The course also explores continuous and real-time simulation. Students are exposed to the techniques used to form conceptual models of mechanical (both translational and rotational), electrical, fluid, thermal, biological, and hybrid systems. The conceptual models are transformed into mathematical models and implemented in a modern simulation package. State-of-the-art tools are explored, and each student is given the opportunity to conduct a simulation study of a complex system. Each student will present a case study and complete a project. Upon completion of the course, the student will be able to conduct or lead the development of the model of a complex physical system, model the input data, and analyze the results to support decisions at key milestones of a system's life cycle.

Prerequisite(s): EN.645.757 Foundations of Modeling and Simulation in Systems Engineering

EN.645.761. Systems Architecting. 3 Credits.

As the systems that systems engineers face become more complex, it is no longer sufficient to use "good engineering practices." The complex systems of today need to be architected before design work can begin. This course examines the principles and art of systems architecting when developing both individual systems and systems that are components of a system or federation of systems. The objective is to provide students with the principles, techniques, and hands-on experience of architecting modern, complex systems. Students will learn the latest architecture development techniques using DoD and commercial architectural frameworks, then extend those frameworks to specific problems involving unique systems development environments. Topics include the management of underlying system and data models and the special architecting requirements of command, control, and communications systems. Special attention will be placed on visualizing architecture artifacts-qualitatively and quantitatively evaluating architectures and the systems model they represent-and utilizing system architectures for investment decisions. Case studies from actual experiences will be presented. Course Note(s): Selected as one of the electives in the MSE or MS program or a required course for the post-master's certificate.

Prerequisite(s): EN.645.769 System Test and Evaluation or advisor and instructor approval.

EN.645.764. Software Systems Engineering. 3 Credits.

This course for systems engineers covers software engineering principles, artifacts, and approaches for the development of software systems. Topics include software engineering processes and metrics; real-time, distributed, configurable, and object-oriented software; alignment of software systems with overall system design; software-unique aspects of planning, requirements, architecture analysis, design, implementation, testing, and maintenance; understanding important software engineering constraints (performance, security, networking, etc.); and technology trends in software engineering today. Student teams will conduct case studies for a project.

Prerequisite(s): EN.645.662 Introduction to Systems Engineering or EN.655.662 and EN.645.667 Management of Systems Projects or permission from the student's academic advisor and the course instructor.

EN.645.766. Systems Engineering Advanced Technology. 3 Credits.

This course emphasizes the impact of recent technological advances on new products, processes, and needs, as well as the roles of the technical manager, program manager, and systems engineer in rapidly-evolving technologies. Subject areas and lecture content track current topics of interest, such as trends and developments in hypersonics, communications, computers, anti-tamper technologies, intelligent machines, nanotechnology, and robotics. Advanced technologies in application areas such as transportation, space, manufacturing, and biomedicine are also discussed. Relatively new systems engineering approaches such model-based systems engineering, agile systems engineering, and "DevOps" are included in the syllabus. In addition, a special enrichment topic for this Cohort is a discussion on the ethics of autonomous weapons led by an internationally-known expert on the subject. Students are encouraged to explore new technology areas and share information with each other. The seminar format encourages student participation that culminates in a term paper on a new or emerging technology area.

EN.645.767. System Conceptual Design. 3 Credits.

This course addresses in detail the systems engineer's responsibilities and activities during the conceptual phases of a system development program. Systems engineering tools commonly employed at this stage of a program are presented along with selected problems that illustrate both the applicability and limitations of commonly employed tools and procedures. The course steps through conceptual design beginning with analysis of needs and objectives and proceeding to the exploration of alternative concepts and the selection of a concept that best meets goals of performance, timeliness, and affordability. Topics include definition of operational scenarios, functional analysis, risk assessment, system tradeoffs, measures of effectiveness, and requirements formulation. Emphasis is on the application of these systems engineering techniques in a team environment to a class project. Students apply systems engineering methods learned from reading and lectures to the development of a realistic system in an ongoing project in a team format.

Prerequisite(s): EN.645.764 Software Systems Engineering or permission of the student's advisor and the course instructor.

EN.645.768. System Design & Integration. 3 Credits.

This course addresses the systems engineering objectives, responsibilities, and activities during the demonstration and validation and the engineering and manufacturing development phases of a system development program. Systems engineering procedures and tools employed during these phases are identified and their use illustrated. Topics include the relationship between a system specification and the system design, systems engineering management plans, risk management, system development models, customer integration into the design process, and design disciplines and practices. The course uses a system problem scenario extensively to illustrate systems engineering principles and specific product design issues.

Prerequisite(s): EN.645.767 System Conceptual Design or permission of the student's advisor and the instructor.

EN.645.769. System Test & Evaluation. 3 Credits.

This course focuses on the application of systems engineering principles to the test and evaluation of system elements and, ultimately, of the total system. Test requirements, selection of critical test parameters, analysis of test results, and determination of remedial action in the event of discrepancies are all systems engineering functions. Topics include validation and verification, similarities and differences in the nature of hardware and software testing, test tools and test procedures, testing during hardware-software integration, quality assurance test, environmental test, and operational test and evaluation. Student problems include scenario case studies using examples developed in the several previous courses.

Prerequisite(s): EN.645.768 System Design and Integration or permission of the student's advisor and the instructor.

EN.645.771. System of Systems Engineering. 3 Credits.

This course addresses the special engineering problems associated with conceiving, developing, and operating systems composed of groups of complex systems closely linked to function as integral entities. The course will start with the underlying fundamentals of systems' requirements, design, test and evaluation, and deployment, and how they are altered in the multi-system environment. These topics will then be extended to information flow and system interoperability, confederated modeling and simulation, use of commercial off-the-shelf elements, and systems engineering collaboration between different organizations. Advanced principles of information fusion, causality theory with Bayesian networks, and capability dependencies will be explored. Several case studies will be discussed for specific military systems of systems, including missile defense and combatant vehicle design, as well as selected commercial examples. Course Note(s): Selected as one of the electives in the MSE or MS program or a required course for the post-master's certificate.

Prerequisite(s): EN.645.769 System Test and Evaluation or advisor and instructor approval.

EN.645.780. Agile Systems Engineering. 3 Credits.

The development of large, complex software-intensive hardware systems has become extremely challenging for systems engineering. For example, automotive designs are now incorporating more than a hundred interconnected individual integrated control units (ICU), each designed to sense environmental factors, both internal and external to the system, and precisely control electro-mechanical devices, all of which are then networked together with the outside world: collectively this evolving technical domain is called a cyber-physical system (CPS). CPS physical and software mechanisms are deeply entwined, operating on dissimilar spatial and temporal scales that exhibit emergent, individually distinct behaviors, and in some systems can include autonomy and the ability to learn. This tight coupling between hardware components and their information-driven software functionality creates an environment of adaptive complexity requiring deliberate, incremental learning intervals with strong feedback throughout the system's development and sustainment lifecycle. This need for continuous learning, and adapting to this learning, is challenging classic systems engineering principles and processes to incorporate new ideas and methods. Systems design and development organizations are turning to a broad set of Agile and Lean methods to manage risk and uncertainty associated with such complexity: the challenge will be in adapting, transforming and extending classic, proven systems engineering methods in order to achieve the same level of disciplined process and delivered value routinely experienced in more traditional projects. This course involves highly-collaborative teamwork requiring at least eight (8) fully-synchronous Zoom-based conferences in order to present student work as a team: meetings are typically two-hours in length and are designed to be highly-engaged, spirited discussions between students and the instructor(s).

Prerequisite(s): EN.645.662 Introduction to Systems Engineering, EN.645.667 Management of Systems Projects, EN.645.764 Software Systems Engineering, EN.645.767 System Conceptual Design, EN.645.768 System Design and Integration and EN.645.769 System Test and Evaluation.

EN.645.800. Systems Engineering Master's Project. 3 Credits.

This course provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific practical project that is suggested by the student and is presented in a formal proposal. The product of the system project is a final report; also required are interim reports and an oral presentation to permit review of the project objectives and approach. This is an independent course that has no formal classes; the student is responsible for developing their own project timeline and works to complete it within one semester. A student typically has a mentor who is a member of the systems engineering faculty. The program chair, vice chair, and mentor review proposals and reports. The total time required for this course is comparable to the combined class and study time for the formal courses. **Course Note(s):** Students who plan to register for this course will need to have a project mentor and a topic for their project and should contact the Systems Engineering Program Office (443-778-6002) four to six weeks prior to the semester start date.

Prerequisite(s): EN.645.769 System Test and Evaluation and an approved project concept from their project mentor and project instructor.

EN.645.801. Systems Engineering Master's Thesis. 3 Credits.

This course is the first of a two-semester requirement designed for students in the Systems Engineering Master's program. Thesis students will conduct independent research in the field of systems engineering, under the guidance of an advisor. The intent of the Master's Thesis research is to advance the body of knowledge and the understanding of systems engineering practices, the improvement of systems engineering practices in industry and in government, the evolution of systems engineering tools and techniques, and the solution of systems development issues in the acquisition of advanced systems. In this course, students will gain a foundation in conducting graduate-level, academic research, including an introduction to research paradigms and methodologies, problem/research question formulation, research design, literature search and critique, proposal preparation, data collection and analysis, research ethics, and the canons of research for engineering and science. At the end of this semester, the student will present their research proposal to their thesis committee. Students interested in pursuing a doctoral degree should enroll in the Thesis Option. **Prerequisite(s):** Completion of all other courses applicable to the Systems Engineering master's degree. **Course Note(s):** Students who plan to register for this course will need to contact the Systems Engineering Program Office (443-778-6002) four to six weeks prior to the semester start date.

EN.645.802. Systems Engineering Master's Thesis. 3 Credits.

This course is the second of a two-semester requirement designed for students in the systems engineering master's program. Thesis students will conduct independent research in the field of systems engineering, under the guidance of an advisor. The intent of the Master's thesis research is to advance the body of knowledge and the understanding of systems engineering practices, the improvement of systems engineering practices in industry and in government, the evolution of systems engineering tools and techniques, and the solution of systems development issues in the acquisition of advanced systems. In this semester, the student will conduct the research outlined in the research proposal developed during EN.645.801, with guidance and oversight from their thesis advisor. At the end of the semester, the student will deliver their thesis paper acceptable for publishing in a professional peer-reviewed journal and will present a defense of their research to their Thesis Committee. Students interested in pursuing a doctoral degree should enroll in the Thesis Option. **Prerequisite(s):** Completion of EN.645.801 Systems Engineering Master's Thesis, the first semester of this two-semester course.

EN.645.803. Post-Master's Systems Engineering Research Project. 3 Credits.

This course is designed for students in the Systems Engineering Post Master's Advanced Certificate Program, who will work with an advisor to conduct independent research in the field of systems engineering leading to a paper that is publishable in a refereed journal. It is also desirable the paper be presented in a professional meeting. The intent of the research is to advance the body of knowledge and the understanding of systems engineering practices, the improvement of systems engineering practices in industry and in government, the evolution of systems engineering tools and techniques, and the solution of systems development issues in the acquisition of advanced systems. **Prerequisite(s):** MSE or MS in Systems Engineering and three of the four required advanced post-master's systems engineering courses. **Course Note(s):** Students who plan to register for this course will need to contact the Systems Engineering Program Office (443-778-6002) four to six weeks prior to the semester start date.

EN.645.804. Post-Master's Systems Engineering Research Project. 3 Credits.

This course is designed for students in the Systems Engineering Post Master's Advanced Certificate Program, who will work with an advisor to conduct independent research in the field of systems engineering leading to a paper that is publishable in a refereed journal. It is also desirable the paper be presented in a professional meeting. The intent of the research is to advance the body of knowledge and the understanding of systems engineering practices, the improvement of systems engineering practices in industry and in government, the evolution of systems engineering tools and techniques, and the solution of systems development issues in the acquisition of advanced systems. Prerequisite(s): MSE or MS in Systems Engineering and three of the four required advanced post-master's systems engineering courses. Course Note(s): Students who plan to register for this course will need to contact the Systems Engineering Program Office (443-778-6002) four to six weeks prior to the semester start date

EN.645.805. Biomedical Systems Engineering Master's Project. 3 Credits.

This course is intended for students in the biomedical systems engineering concentration and provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific biomedical systems project that is suggested by the student and is presented in a formal proposal. The product of the biomedical system project is a final report, as well as interim reports and an oral presentation to permit review of the project objectives and approach. A student typically has a mentor who is a member of the biomedical or systems engineering faculty. The biomedical program chair, the systems engineering vice chair, a systems engineering mentor, and a biomedical mentor review student proposals and reports. The total time required for this course is comparable to the combined class and study time for the formal courses. Course prerequisite: Completion of all courses applicable to the biomedical systems engineering master's degree.

EN.645.806. Information Assurance Systems Engineering Master's Project. 3 Credits.

This course is intended for students in the Cybersecurity Systems Engineering concentration and provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific cyber security system project that is suggested by the student and is presented in a formal proposal. The product of the cyber security system project is a final report, as well as interim reports and an oral presentation to permit review of the project objectives and approach. A student typically has a mentor who is a member of the computer science or systems engineering faculty. The computer science program chair, the systems engineering vice chair, a systems engineering mentor, and a computer science mentor review student proposals and reports. The total time required for this course is comparable to the combined class and study time for the formal courses. Course prerequisite: Completion of all other courses applicable to the Cybersecurity Systems Engineering master's degree.

EN.645.807. Software Systems Engineering Master's Project. 3 Credits.

This course is intended for students in the software systems engineering focus area and provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific software systems project that is suggested by the student and is presented in a formal proposal. The product of the software systems project is a final report, as well as interim reports and an oral presentation to permit review of the project objectives and approach. A student typically has a mentor who is a member of the computer science or systems engineering faculty. The computer science program representative, the systems engineering vice chair, a systems engineering mentor, and a computer science mentor review student proposals and reports. The total time required for this course is comparable to the combined class and study time for the formal courses. Course prerequisite: Completion of all other courses applicable to the software systems engineering master's degree.

EN.645.808. Human Systems Engineering Master's Project. 3 Credits.

This course is intended for students in the human systems engineering concentration and provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific human systems project that is suggested by the student and is presented in a formal proposal. The product of the human systems project is a final report, as well as interim reports and an oral presentation to permit review of the project objectives and approach. A student typically has a mentor who is a member of the systems engineering or human systems concentration faculty. The systems engineering chair, a systems engineering mentor, and a human systems concentration mentor review student proposals and reports. The total time required for this course is comparable to the combined class and study time for the formal courses. Course prerequisite: Completion of all courses applicable to the human systems engineering master's degree.