HEALTHCARE SYSTEMS ENGINEERING

The Healthcare Systems Engineering program at Johns Hopkins University provides engineers and healthcare professionals with the in-depth knowledge and skills necessary to apply systems engineering principles and best practices to address today's healthcare challenges and create healthcare of the future. Students will be well prepared to re-engineer healthcare delivery on a broad scale by using a systems approach. This approach will lead to solutions that seamlessly integrate technology into the cultural and workflow dynamics prevalent in healthcare, while holistically addressing interoperability, security/privacy, safety, cost, performance (i.e., outcomes, etc.), and other key requirements.

Instructors are practicing systems engineers or healthcare professionals who incorporate real-world problem-solving activities and case studies into discussion topics.

Program Committee

Alan Ravitz, Program Chair
Principal Professional Staff
JHU Applied Physics Laboratory

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Principal Professional Staff
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Deputy Vice Chair for Intensive Care Unit (ICU) Operations
Associate Professor of Anesthesiology and Critical Care Medicine

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Chris Unger
Healthcare Working Group Lead, INCOSE
Chief Systems Engineer, GE Healthcare, Retired

Programs

- Healthcare Systems Engineering, Master of Science (https://e-catalogue.jhu.edu/engineering/engineering-professionals/healthcare-systems-engineering/healthcare-systems-engineering-master-science/)

Courses

EN.655.662. Intro to Healthcare Systems Engineering. 3 Credits.
This course introduces students to the fundamental principles of healthcare systems engineering and their application to the development of complex systems. It describes how the systems engineering viewpoint differs from that of the healthcare provider, as well as the essential role that systems engineering plays as an integral component of program management. Topics include integrated systems engineering life cycle purpose and constructs, delineation of different complex system types, requirements analysis, concept definition, system synthesis, design trade-offs, risk assessment, interface definition, engineering design, system integration, and related systems engineering activities. The course defines the breadth and depth of the knowledge that the healthcare systems engineer must acquire concerning the characteristics of the diverse components that constitute the total system. Special topics such as architectures, interfaces, simulation and models, and test and evaluation are discussed in relation to the healthcare systems engineering viewpoint. Students address typical systems engineering problems that highlight important healthcare issues and methods of technical problem resolution.

EN.655.667. Management of Healthcare 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 healthcare systems project manager. From the development of a proposal to the delivery of a product and/or service 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.

EN.655.705. Transformational Capabilities in Health. 3 Credits.
This course introduces students to selected transformational capabilities that are currently impacting healthcare systems and will continue for the foreseeable future. The selected transformational capabilities will be discussed in the context of a healthcare systems thinking-engineering strategy to best leverage the capability for a more cohesive and integrated healthcare ecosystem. The topics that will be discussed include: Personal Wearables and Apps, Personalized Medicine, Digital Health, Data Science and AI/ML, Telehealth & Telemedicine, Predictive Analytics/Forecasting, Virtual/Augmented Reality, Interoperability, Resilient Systems, and Supply Chains. Each transformation capability will be delineated with its unique attributes, applied to selected healthcare ecosystems, and then discussed within a systems thinking-engineering development approach to help demonstrate its overall impact and comprehensive integrated value.

EN.655.767. Healthcare System Conceptual Design. 3 Credits.
This course addresses in detail the healthcare systems engineer's responsibilities and activities during the conceptual phases of a healthcare 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 to the solving current healthcare issues. The course steps through conceptual design beginning with analysis of needs and objectives and proceeding to the exploration of 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 trade-offs, 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.655.662 Introduction to Healthcare Systems Engineering and EN.655.667 Management of Healthcare Systems Projects, or permission of the student's faculty advisor and the course instructor.

EN.655.768. Healthcare System Design & Integration. 3 Credits.
This course addresses the healthcare systems engineering objectives, responsibilities, and activities during the engineering development phase of the system lifecycle using Model Based Systems Engineering (MBSE) tools. Healthcare systems engineering procedures and tools used during this phase are identified and their use illustrated. Topics include the relationship between a system specification and the system design, risk management and patient safety, system design models, healthcare provider and patient integration into the design process, and healthcare system design disciplines and practices. The course uses a healthcare system scenario extensively to apply systems engineering principles and practices through development of a Systems Modeling Language (SysML) model.
Prerequisite(s): EN.655.767 Healthcare System Conceptual Design or permission of the student's faculty advisor and the instructor.

EN.655.769. Healthcare System Test and Evaluation. 3 Credits.
This course focuses on the application of systems engineering principles to the test and evaluation of healthcare 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.655.768 Healthcare System Design and Integration or permission of the student's faculty advisor and the instructor.

EN.655.771. Healthcare Systems. 3 Credits.
This course will cover the fundamental elements of modern healthcare systems, including their structure, processes, and relation to information systems and system interfaces. It also covers the organization, financing, and delivery of healthcare in the United States. It also discusses several potential small and large-scale reforms to the U.S. healthcare system and evaluates their likely effects on healthcare spending, quality of care, and access to care.
Prerequisite(s): EN.655.662 or concurrent with EN.655.662 or permission of the student's faculty advisor and the instructor.;Course too similar

EN.655.800. Healthcare Systems Engineering Capstone Project. 3 Credits.
This course provides the experience of applying systems engineering principles and skills learned in the formal courses to a specific practical healthcare system 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. A student typically has a mentor who is a member of the Systems Engineering faculty. The program 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 (formerly 645.770). It is self-paced and often takes more than one semester to complete.
Prerequisite(s): EN.655.769 Healthcare System Test and Evaluation and completion of at least 3 of the four required electives and permission of course instructor.