

# INFORMATION SYSTEMS ENGINEERING

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The part-time Information Systems Engineering program balances theory with practice by offering traditional and cutting-edge courses that accommodate working professionals with various backgrounds. The program appeals to engineers, scientists, and analysts by providing them with the opportunity to design large-scale information systems, create business analytics, conduct complex systems analyses, and create sophisticated distributed and secure systems.

Courses are offered at the Applied Physics Laboratory and online.

## Program Committee

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## Programs

- Information Systems Engineering, Graduate Certificate (<http://e-catalog.jhu.edu/engineering/engineering-professionals/information-systems-engineering/information-systems-engineering-graduate-certificate/>)

- Information Systems Engineering, Master of Science (<http://e-catalog.jhu.edu/engineering/engineering-professionals/information-systems-engineering/information-systems-engineering-master-science/>)
- Information Systems Engineering, Post-Master's Certificate (<http://e-catalog.jhu.edu/engineering/engineering-professionals/information-systems-engineering/information-systems-engineering-post-masters-certificate/>)

## Courses

### EN.635.601. Foundations of Information Systems Engineering. 3 Credits.

Creating and operating large-scale information systems requires a holistic approach that manages the blending of software, hardware, networks, and security inherent in modern systems. This course introduces key elements and processes required for designing, analyzing, developing, and integrating complex information systems. The course focuses on the systems engineering approach with specific emphasis on design, development, and deployment. Topics covered include requirements engineering, architecture development, security engineering, cost-benefit analysis, information and networking technologies, and operations. Course Note(s): The required foundation courses may be taken in any order but must be taken before other courses in the degree.

### EN.635.611. Principles of Network Engineering. 3 Credits.

This course provides a technical, introductory overview of networking and telecommunications for the engineering practitioner. Topics include voice, data, and video communication system fundamentals, including signaling, frequency concepts, transmission media, multiplexing, spread spectrum, signal encoding, error control, and basic terminology. The OSI and TCP/IP reference models are examined along with the basic concepts of protocols, service interfaces, encapsulation, and layering. The course also covers networking and telecommunication techniques, applications technology, and networking topologies and Internetworking architectures. Specific areas discussed include LAN system fundamentals, such as Ethernet and IEEE 802.11 wireless; and WAN system fundamentals, such as circuit-switching, packet-switching, IP routing, cellular, satellite, frame relay, label switching, and Asynchronously Transfer Mode.

### EN.635.621. Principles of Decision Support Systems. 3 Credits.

This course focuses on the use and application of information systems to support the decision-making process. Knowledgebased systems, neural networks, expert systems, electronic meeting systems, group systems and web-based systems are discussed as a basis for designing and developing highly effective decision support systems. Data models, interactive processes, knowledge-based approaches and integration with database systems are also described. Theoretical concepts are applied to real-world applications.

**EN.635.631. Foundations of Data Analytics. 3 Credits.**

This foundation course provides an overview of data analysis process, and introduces students to common techniques for data preprocessing, feature extraction, and the creation of statistical models. In particular, students will develop competence in areas of high importance for data scientists and engineers, such as: exploring the trade-off between bias and variance, selecting and creating features, regularizing models, determining optimal hyperparameters, and evaluating model performance. Multiple datasets and data types (e.g., unstructured text, imagery, and time-varying signals) will be considered with the goal of building student confidence across a spectrum of analysis challenges. Particular topics include linear and non-linear regression, decision trees, various approaches to dimensionality reduction, clustering, topic modeling, Bayesian methods, and neural networks. Prerequisite(s): Programming experience in Python, introductory linear algebra, and probability theory recommended.

**EN.635.632. Foundations of Data Engineering. 3 Credits.**

This course provides a survey of concepts and techniques used in data engineering. With the emergence of data science as a new field of study, data engineering has gained prominence as a discipline in its own right. Designing and deploying data intensive applications for production environments require skills and experience beyond data science. The data engineer needs to be able to understand the reliability, scalability, and performance aspects of data stores and pipelines required for data analysis. Experience with relational databases and extract transform and load (ETL) techniques used in data warehousing are necessary foundations. The engineer also needs knowledge of publish and subscribe architectures as well as large scale computational clusters used for big data. This class will use data analysis examples to illustrate the concepts of data models, query languages, and data encoding. The concepts of replication and partitioning will be studied as they relate to transactional, batch, and streaming systems.

**Prerequisite(s):** EN.635.601 Foundation of Information Systems Engineering. Prior experience with databases, SQL, and Python is recommended.

**EN.635.661. Principles of Human Computer Interaction. 3 Credits.**

Well-designed human-computer interaction (HCI) is critical to the success of computer and information systems. This course focuses on the HCI design process and covers the underlying scientific principles, HCI design methodology, and the user-interface technology used to implement HCI. Topics include human cognition, HCI theories, user observation and task analysis, prototyping and evaluation techniques, user interface modalities and graphical user interface components, and accessibility. Selected additional topics may include HCI in website design, support of collaborative work, human interaction with automation, and ubiquitous computing. Student design projects are an integral part of the course. Reading the current HCI research literature is also required.

**EN.635.671. Data Recovery & Continuing Operations. 3 Credits.**

Data recovery and continuing operations refers to the processes, plans, and technologies required for an enterprise to achieve resiliency given unexpected events that may disrupt IT operations. This course provides an overview of the storage technologies to address backup, disaster recovery, and business continuity. Technologies that address auditing, redundancy, and resiliency in the infrastructure (e.g., networks, power, cooling, etc.) are described. Beyond the technologies, processes and plans for continuing operations are covered, including issues such as business continuity, disaster recovery, and risk management.

**Prerequisite(s):** EN.635.621 Principles of Decision Support Systems is recommended and may be taken concurrently.

**EN.635.672. Privacy Engineering. 3 Credits.**

Personal information has become a new class of digital property with immense value in commerce and of intense importance to national security and intelligence. Engineering any information system now requires a professional to protect privacy, preserve the information's functional value, and navigate complex domestic and international legal and engineering rules. Students will use new visual modeling and analysis tools for designing and executing privacy solutions in both the commercial and governmental sectors. Students will build a final specification for a privacy solution involving regulated personal information.

**EN.635.673. Critical Infrastructure. 3 Credits.**

This course focuses on understanding the history, the vulnerability, and the need to protect our Critical Infrastructure and Key Resources (CIKR). We will start by briefly surveying the policies that define the issues surrounding CIKR and the strategies that have been identified to protect them. Most importantly, we will take a comprehensive approach to evaluating the technical vulnerabilities of the sixteen identified sectors, and we will discuss the tactics that are necessary to mitigate the risks associated with each sector. These vulnerabilities will be discussed from the perspective of technical journals/articles that detail recent and relevant network-level CIKR exploits. We will cover well-known vulnerable systems such as the Internet, SCADA, and lesser-known systems such as E911 and industrial robots. Students will be challenged with hacker-type home works inspired by current SANS NewsBites and the instructor's research, and will work on a team-based semester-long project.

**EN.635.676. Cybersecurity in Information Systems. 3 Credits.**

This course describes the systems security engineering process, focusing on security during the design and implementation of information systems. Topics include architecture and design principles, risk assessment, resiliency, and security metrics. The course addresses emerging topics in cybersecurity including wireless security, cloud security, cross domains and the government standards and processes for secure information systems; surveys many aspects of cybersecurity and its impact on the enterprise; and lays the groundwork to architect and build a natively more secure system that can withstand hacking attacks and continue to deliver basic functionality to the enterprise. We will address the federal government standards and recommendations as well as industry's best practices. Students will cover the basic concepts of information security and research the latest security incidents including external attacks and internal leaks to assess and analyze the exploited vulnerabilities. By learning from current incidents, students can build systems that adapt quickly to emerging threats and potentially continue to serve the enterprise, even while under attack. Additionally, the course addresses the assessment of emerging technologies to determine the potential threats to the enterprise as well as the usability to secure the enterprise. Finally, we will address the subject of legal and ethical access control and the balance between privacy and security.

**EN.635.682. Website Development. 3 Credits.**

This course covers the design and implementation of websites. Various web standards, as developed by the World Wide Web Consortium and by browser manufacturers, are studied. HTML 5 specifications are covered, including topics such as text control, images, hypertext links, forms, tables, iframes, and embedded objects (e.g., video and applets). Cascading style sheets, a web scripting language (such as JavaScript), CGI programming, and their use in Dynamic HTML are also covered. Design and development topics include ease of navigation, download time, maintaining a consistent look and feel across multiple pages, making a website work well across multiple browsers, and web server selection and configuration.

**EN.635.683. E-Business: Models, Architecture, Technologies, and Infrastructure. 3 Credits.**

This course explores fundamental aspects of the e-Business (electronic business) phenomenon that is currently sweeping through the global economy, as well as design principles and technology used to build computer-based systems in order to support the notion of e-Business. E-Business (electronic business) is an umbrella term, an interdisciplinary topic encompassing both business and technology. This topic addresses a variety of business activities, business processes, and strategic business functions conducted over the Internet in order to service customers, to collaborate with business partners, and to maintain and sustain competitive advantage in the networking economy. The course introduces contemporary management philosophies as they have come to be used for the marketing, selling, and distribution of goods and services through the Internet and other electronic media. The course explores approaches of defining drivers and use cases of conducting electronic business. This course provides an overview of principles and analysis of different models of electronic business. It enables students to design effective e-Business models built on a foundation of business concepts, knowledge of the e-Business environment, and an understanding of the influence of the Internet on business stakeholders, including customers, suppliers, manufacturers, service makers, regulators, managers, and employees. In this course students undertake value analysis and learn to describe value propositions. Business architecture and software infrastructure used to engineer and build e-Business systems will be explained. The modern information technologies associated with the delivery of business capabilities over the Internet will be discussed. The course content will be reinforced by a variety of assignments.

**EN.635.711. Advanced Topics in Network Engineering. 3 Credits.**

This course is designed to provide an advanced treatment of key topic areas in networking and telecommunications for students who have mastered the basic principles of network engineering. Key operational systems, protocols, and technologies are explored in local, wide, metro-area, storage, and wireless networking. Major topic areas include advanced LAN/WLAN technologies (Power over Ethernet, IEEE 802.1x authentication, VLANs, link aggregation, etc.), Storage Area Network technologies, Virtualized/Cloud networking, Optical Networking, IPv6, Spanning Tree and Dynamic IP routing protocols, "LastMile" Networking (DSL, Cable Modems, etc.), Label Switching, Multicasting, and Multicast routing, real-time application support mechanisms, Quality of Service protocols, Advanced Transport Layer topics (Congestion Notification, TCP options, etc.), and Network Security (address translation, VPNs, stateful inspection, etc.). A major component of the course will be a design project on one of the topic areas covered in the class.

**Prerequisite(s):** EN.635.611 Principles of Network Engineering or EN.605.671 Principles of Data Communications Networks or equivalent.

**EN.635.775. Cyber Operations, Risk, and Compliance. 3 Credits.**

This course provides a solid foundation of potential civil and criminal areas of liability, and certain areas in which compliance and risk management are critical. The overarching theme is detection and reduction of potential legal/cybersecurity risks. We start by exploring the legal and regulatory environment that influences and supports cyber-based activities and programs, focusing on multidisciplinary or integrated views of enterprise risk management. We will address key risk management issues from the legal and cybersecurity aspects and analyze legal/ cybersecurity issues in several of the critical infrastructure sectors, such as the financial services, healthcare and public health, and transportation systems sectors. We also review legal and regulatory compliance issues to address cybersecurity risk management for systems development, acquisition, and operation. This includes material impacting the manner in which the cyber community operates, for example, FITARA (Federal Information Technology Acquisition Reform Act) Enhancement Act of 2017. We then review the authoritative guidance provided by the National Institute of Standards and Technology (NIST) Cybersecurity Framework. The Framework is voluntary for the sixteen critical information sectors and mandatory for the federal government, hence the focus on NIST. Risk management threat detection and avoidance is analyzed from an integrated legal/cybersecurity perspective, including system objectives to avert legal liability and minimize enterprise and human loss. Examples address financial services, healthcare and public health, and transportation (mobile devices and autonomous vehicles) systems, and cyber-physical systems (CPS) or Internet of Things (IoT). The overall constitutional and statutory basis within which all cyber law and policy operates is identified and reviewed.

**EN.635.776. Building Information Governance. 3 Credits.**

Businesses and government agencies confront increasingly complex rules and standards establishing the requirements for how digital information assets are to be created, stored, maintained, accessed, transmitted, received, and disposed. Information system engineers face enormous compliance risks, functional inefficiencies, and remediation costs if they are unprepared to navigate and master all of the technology, business, and legal rules against which digital information must be governed. All of these variables have become more complex as governments and industry partner more closely in counterterrorism investigations and defenses. This course enables engineers to explore and understand these rules and to develop better leadership skills across teams engaged in designing and managing complex governance projects. Assignments will expose engineers to, and teach them to navigate, the traps that global, cloud-based services present. Students completing the course will be able to contribute effectively to the cutting-edge, demanding projects ahead—"big data" transactions, real-time reporting to official agencies, electronic discovery, privacy, and compliance. Students will be expected to actively participate in class exercises, complete written assignments, and develop and present a final written governance proposal.

**EN.635.792. Management of Innovation. 3 Credits.**

A critical issue for entrepreneurs and technical managers is how to translate opportunity into competitive advantage. This course explores the management of innovation, including the technical transition of applied R&D into products, the planning and launching of new products, and product management. Management of discontinuous technologies will be explored. The impact of competition by the introduction of new discontinuous technology will be addressed. Managing engineers through the creative process, as well as innovation and technological evolution, will be covered. The course includes both formal and guest lectures. Case studies will be used as an important learning vehicle.

**EN.635.795. Information Systems Engineering Capstone Project. 3 Credits.**

This course is designed for students who would like to conduct a major independent project involving a substantial enterprise information system design that builds upon elements of the ISE curriculum. The project includes requirements analysis, IT architecture design, network design, software integration, decision support applications, and deployment planning. Interim deliverables include presentations to the course advisors. Project proposals are required and a mentor will be assigned to the student. Prerequisite(s): Completion of eight courses in the ISE curriculum, including all ISE foundation courses. Course Note(s): Students may not receive graduate credit for both EN.635.795 and EN.635.802 Independent Study in Information Systems Engineering II.

**EN.635.801. Independent Study in Information Systems Engineering I. 3 Credits.**

This course permits graduate students in Information Systems Engineering to work with a faculty mentor to explore a topic in depth or conduct research in selected areas. Requirements for completion include submission of a significant paper. Prerequisite(s): Seven ISE graduate courses including the foundation courses, three concentration area courses, and two courses numbered 635.7xx; or admission to the Post-Master's Certificate. Students must also have permission of a faculty mentor, the student's academic advisor, and the program chair.

**EN.635.802. Independent Study in Information Systems and Technology II. 3 Credits.**

Students wishing to take a second independent study in information systems engineering should sign up for this course. Prerequisite(s): EN.635.801 Independent Study in Information Systems Engineering I and permission of a faculty mentor, the student's academic advisor, and the program chair. Course Note(s): Students may not receive graduate credit for both EN.635.802 and EN.635.795 Information Systems Engineering Capstone Project.