

**SIE 250 – Intro to Systems and Industrial Engineering (3 units)**

Description: System modeling the elementary constructs and principles of system models including discrete-time, discrete-state system theory; finite state machines; modeling components, coupling, modes, and homomorphism system design; requirements, life-cycle, performance measures and cost measures, tradeoffs, alternative design concepts, testing plan, and documentation. Applications and case studies from engineering. Prerequisite(s): ENGR 102, MATH 129. Usually offered: Fall, Spring.

**SIE 265 – Engineering Management I (3 units)**

Description: Fundamentals of economic analysis and the time value of money for engineers. Construction of financial models in EXCEL including Income, Cash Flow, and Balance Sheet. Estimation of required capital and project acceptance criteria. Prerequisite(s): MATH 129, ENGR 102. Identical to: ENGR 265. Usually offered: Fall, Spring.

**SIE 270 – Mathematical Foundations of Systems and Industrial Engineering (3 units)**

Description: Basics of data structures, transformations, computer methods, their implementation in MATLAB, and their applications in solving engineering problems. Prerequisite(s): ECE 175, MATH 129, PHYS 141. Usually offered: Spring, Summer

**SIE 277 – Object-Oriented Modeling and Design (3 units)**

Description: Modeling and design of complex systems using all views of the Unified Modeling Language (UML). Most effort will be in the problem domain (defining the problem). Some effort will be in the solution domain (producing hardware or software). Prerequisite(s): C SC 110 or ECE 175. Usually offered: Fall, Spring.

**SIE 295S – Systems and Industrial Engineering Sophomore Colloquium (1 unit)**

Description: A colloquium designed to help students understand what SIE's do. Students will interact with speakers and take tours to local companies. The course helps students select course options within the SIE programs and helps focus on possible SIE applications areas. Usually offered: Fall, Spring.

*Note: Upper division courses, SIE 3xx and SIE 4xx, require Advanced Standing for registration. Students must contact the department to apply for advanced standing.*

**SIE 305 – Introduction to Engineering Probability and Statistics (3 units)**

Description: Axioms of probability, discrete and continuous distributions, sampling distributions. Engineering applications of statistical estimation, hypothesis testing, confidence intervals. Prerequisite(s): MATH 129. Usually offered: Fall, Spring, Summer.

**SIE 321 – Probabilistic Models in Operations Research (3 units)**

Description: Probability, Markov chains, Poisson processes, queuing models, reliability models. Prerequisite(s): SIE 305. Usually offered: Spring.

**SIE 330R – Engineering Experiment Design (3 units)**

Description: Design and analysis of observational and factorial experiments employing numerical and graphical methods. Topics include control charts, probability plots, multiple regression analysis, confidence and prediction intervals and significance tests. Prerequisite(s): SIE 305. Usually offered: Spring.

**SIE 340 – Deterministic Operations Research (3 units)**

Description: Linear programming models, solution techniques, sensitivity analysis and duality. Prerequisite(s): Prerequisite(s): SIE 270. Usually offered: Fall, Summer.

**SIE 367 – Engineering Management II (3 units)**

Description: Strategic, tactical and operational planning; innovation and technological cycles; the elements of entrepreneurship, and human relations topics for technical managers. Prerequisite(s): SIE 265. Usually offered: Spring.

**SIE 370 – Embedded Computer Systems (4 units)**

Description: Boolean algebra, combinational and sequential logic circuits, finite state machines, simple computer architecture, assembly language programming, and real-time computer control. The computer is used as an example of systems engineering design; it is analyzed as a system, not as a collection of components. Typical structure: 3 hours lecture, 3 hours laboratory. Usually offered: Fall, Spring.

**SIE 377 – Software for Engineers (3 units)**

Description: Rapid prototyping of decision support systems using VBA and Python with Excel and external packages to solve for optimization, build models and simulations, and create scheduling and forecasting tools. Decision support system types include financial, supply chain, product portfolio and facility location and operations. Prerequisite(s): ECE 175. Usually offered: Fall.

**SIE 383 – Integrated Manufacturing Systems (3 units)**

Description: Introduction to the integrated manufacturing enterprise and automation. Topics include computer-aided design, process planning, computer numerical control machining, machine vision, application of robots and automation. Typical structure: 2 hours lecture, 2 hours laboratory. Usually offered: Spring.

**SIE 406 – Quality Engineering (3 units)**

Description: Quality, improvement and control methods with applications in design, development, manufacturing, delivery and service. Topics include modern quality management philosophies, engineering/statistical methods (including process control, control charts, process capability studies, loss functions, experimentation for improvement) and TQM topics (customer driven quality, teaming, Malcolm Baldrige and ISO 9000). May be convened with SIE 506. Prerequisite: SIE 305. Usually offered: Spring. Offered fall starting fall 2022.

**SIE 408 – Reliability Engineering (3 units)**

Description: This is a three-credit course configured for well-qualified seniors, graduate students, and engineering professionals and practitioners. It is concerned with determining the probability that a component or system, whether simple or complex, will function as intended. The scope of this course includes: (1) Root cause analysis of critical failures, (2) reliability models of components and systems, (3) development of statistical methods for estimating the reliability of a product, (4) use of software tools to perform model development and analysis, and (5) methodologies to influence system designs. May be convened with SIE 508. Prerequisite: SIE 305. Usually offered: Fall.

**SIE 410A – Human Factors and Ergonomics in Design (3 units)**

Description: Consideration of human characteristics in the requirements for design of systems, organizations, facilities and products to enable human-centered design which considers human abilities, limitations and acceptance. Co-requisite or Prerequisite: SIE 305. Usually offered: Fall, Spring.

**SIE 414 – Law for Engineers and Scientists (3 units)**

Description: Topics covered in this course include patents, trade secrets, trademarks, copyrights, product liability contracts, business entities, employment relations and other legal matters important to engineers and scientists. May be convened with SIE 514. Usually offered: Spring.

**SIE 415 – Technical Sales and Marketing (3 units)**

Description: Principles of the engineering sales process in technology-oriented enterprises; selling strategy, needs analysis, proposals, technical communications, electronic media, time management and ethics; practical application of concepts through study of real-world examples. May be convened with SIE 515. Usually offered: Fall, Spring.

**SIE 422 -- Engineering Decision Making Under Uncertainty (3 units)**

Description: Application of principles of probability and statistics to the design and control of engineering systems in a random or uncertain environment. Emphasis is placed on Bayesian decision analysis. Prerequisite(s): SIE 305. May be convened with: SIE 522. Usually offered: Fall.

**SIE 430 -- Engineering Statistics (3 units)**

Description: Statistical methodology of estimation, testing hypotheses, goodness-of-fit, nonparametric methods and decision theory as it relates to engineering practice. Significant emphasis on the underlying statistical modeling and assumptions. Prerequisite(s): SIE 305. May be convened with SIE 530. Usually offered: Fall.

**SIE 431 -- Simulation Modeling and Analysis (3 units)**

Description: Discrete event simulation, model development, statistical design and analysis of simulation experiments, variance reduction, random variate generation, Monte Carlo simulation. Prerequisite(s): SIE 305. May be convened with: SIE 531. Usually offered: Fall, Spring.

**SIE 432 –Sports Analytics (3 units)**

Description: This course provides fundamental analytical skills necessary to analyze data and make decisions using sports examples. These skills include critical thinking, statistical analysis, computer programming, and data visualization which are generally applicable to other areas of engineering and business. May be convened with SIE 532. Prerequisite: SIE 305. Usually offered: Summer.

**SIE 433 –Fundamentals of Data Science for Engineers (3 units)**

Description: This course will provide senior undergraduate and graduate students from diverse engineering disciplines with fundamental concepts, principles and tools to extract and generalize knowledge from data. Students will acquire an integrated set of skills spanning data processing, statistics and machine learning, along with a good understanding of the synthesis of these skills and their applications to solving problem. The course is composed of a systematic introduction of the fundamental topics of data science study, including: 1) principles of data processing and representation, 2) theoretical basis and advances in data science, 3) modeling and algorithms, and 4) evaluation mechanisms. The emphasis in the treatment of these topics will be given to the breadth, rather than the depth. Real-world engineering problems and data will be used as examples to illustrate and demonstrate the advantages and disadvantages of different algorithms and compare their effectiveness as well as efficiency, and help students to understand and identify the circumstances under which the algorithms are most appropriate. May be convened with SIE 533. Prerequisite: SIE 305. Usually offered: Fall. Offered spring, starting spring 2023.

**SIE 440 -- Survey of Optimization Methods (3 units)**

Description: Survey of methods including network flows, integer programming, nonlinear programming, and dynamic programming. Model development and solution algorithms are covered. Prerequisite(s): SIE 340. May be convened with: SIE 540. Usually offered: Spring.

**SIE 454A -- The Systems Engineering Process (3 units)**

Description: Process and tools for systems engineering of large-scale, complex systems: requirements, performance measures, concept exploration, multi-criteria tradeoff studies, life cycle models, system modeling, etc. May be convened with SIE 554A. Usually offered: Fall, Spring.

**SIE 455 – Sensor Systems Engineering (3 units)**

Description: The primary purpose of this course is to provide students with a system level understanding of sensor development. The student will see the development of remote sensing techniques beginning with high level requirements through concept of operations, architecture development, subsystem modeling and culminating in integration, validation and verification. The student will be exposed to key design parameters for radar and Electro Optical sensing systems that drive both system cost and performance. Advanced multi-sensor systems and adaptive signal processing will also be discussed. May be convened with SIE 555. Prerequisite(s): SIE 305. Usually offered: Spring.

**SIE 457 – Project Management (3 units)**

Description: Foundations, principles, methods and tools for effective design and management of projects in technology-based organizations. This course focuses on the scope, time, cost, performance and quality concerns of engineering projects characterized by risk and uncertainty. Initiating, planning, executing, monitoring, controlling and closing process are addressed. Students design and complete a project from concept through completion. Project Management software is utilized. May be convened with SIE 557. Usually offered: Fall, Spring.

**SIE 458 – Model Based Systems Engineering (3 units)**

Description: An introduction to model-based systems engineering (MBSE), which is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. The course emphasizes practical use of the Systems Modeling Language (SysML) and MBSE methods. May be convened with SIE 558. Co-requisite or Prerequisite: SIE 454A. Usually offered: Spring.

**SIE 462 -- Production Systems Analysis (3 units)**

Description: Production systems, quantitative methods for forecasting, aggregate planning, inventory control, materials requirement planning, production scheduling, manpower planning and facility design. May be convened with SIE 562. Prerequisite(s): SIE 305, SIE 340 or consent of advisor. Usually offered: Spring.

**SIE 464 – Cost Estimation (3 units)**

Description: Focuses on principles of cost estimation and measurement systems with specific emphasis on parametric models. Approaches from the fields of hardware, software and systems engineering are applied to a variety of contexts (risk assessment, judgment & decision making, performance measurement, process improvement, adoption of new tools in organizations, etc.). Material is divided into five major sections: cost estimation fundamentals, parametric model development and calibration, advanced engineering economic principles, measurement systems, and policy issues. May be convened with SIE 564. Prerequisite: SIE 305. Usually offered: Spring.

**SIE 465 – Supply Chain Management (3 units)**

Description: Fundamentals of Supply Chain Management including inventory/logistics planning and management, warehouse operations, procurement, sourcing, contracts and collaboration. May be convened with: SIE 565 Prerequisite: SIE 305 and SIE 340. Usually offered: Spring.

**SIE 466 – Life Cycle Analysis for Sustainable Design and Engineering (3 units)**

Description: This course will provide senior undergraduate and graduate students the conceptual, methodological, and scientific bases to quantify and improve the impact of engineering decisions on the environment, with a focus on applying life cycle analysis (LCA). The course will foster students to assess the environmental sustainability early on in their research to help design and develop more sustainable materials, products, and processes including manufacturing, logistics, and supply chain. Main topics covered include concept of life cycle thinking, computational structure of LCA, process based LCA, economic input-output LCA, LCA software tools and databases, case studies, recent development, and advanced topics in LCA. The students will be able to approach problems with life cycle perspectives, conduct LCA according to the ISO 14040 standards, and understand the strengths and weaknesses of LCA studies. May be convened with SIE 566. Usually offered: Spring.

### **SIE 471 – Systems Cyber Security Engineering (3 units)**

Description: The purpose of this course is to introduce selected topics, issues, problems, and techniques in the area of System Cyber Security Engineering (SCSE), early in the development of a large system. Students will explore various techniques for eliminating security vulnerabilities, defining security specifications / plans, and incorporating countermeasures in order to achieve overall system assurance. SCSE is an element of system engineering that applies scientific and engineering principles to identify, evaluate, and contain or eliminate system vulnerabilities to known or postulated security threats in the operational environment. May be convened with SIE 571. Prerequisite: ECE 175 or CSC 110. Usually offered: Fall.

### **SIE 472 – Information Security and Research (INSuRE) (3 units)**

Description: This course engages students in diverse and varied national cybersecurity/information systems security problems, under an existing and very successful umbrella program called 'INSuRE', that enables a collaboration across several universities, Cyber professionals and cross-disciplined Cyber related technologies. Led by Purdue University, and made possible by a grant from the NSA and NSF, INSuRE has fielded a multi-institutional cybersecurity research course in which small groups of undergraduate and graduate students work to solve unclassified problems proposed by NSA, other US government agencies, and/or private organizations and laboratories. Students will learn how to apply research techniques, think clearly about these issues, formulate and analyze potential solutions, and communicate their results with sponsors and other participating universities. This may be convened with SIE 572. Strongly recommended: SIE 471, ECE 478. Usually offered: Spring.

### **SIE 473 – Engineering of Trustworthy Secure Systems (3 units)**

Description: The purpose of this course is to explore widely accepted security frameworks, industry standards, and techniques employed in engineering trustworthy secure and resilient systems. We will study and explore several National Institute of Standard and Technology (NIST) frameworks such as the Cyber Security Framework (CSF), the Risk Management Framework (RMF), and other standards. These widely adopted standards have been developed to ensure that the appropriate security principles, concepts, methods, and practices are applied during the system development life cycle (SDLC) to achieve stakeholder objectives for the protection of assets—across all forms of adversity characterized as disruptions, hazards, and threats. We will also explore case studies within the Department of Homeland Security's (DHS) 16 Critical Infrastructure elements (shown in the figure below), to understand how government and private sector participants within the critical infrastructure community work together to manage risks and achieve security and resilient outcomes. Cyber resiliency is the ability to anticipate, withstand, recover from, and adapt to adverse conditions, stresses, attacks, or compromises on systems that use or are enabled by cyber resources regardless of the source. May be convened with SIE 573. Usually offered: Spring.

### **SIE 474 – Information Analytics and Decision-Making in Engineering (3 units)**

Description: Recent advances in computational and information technology allow the collection and evaluation of vast volumes of data. This explosion in information has amplified the need to understand the value of information and how to use available information to make better decisions that in turn affect the environment. The course will cover information valuation, decision-making, and information economics in non-strategic and strategic settings. Prerequisite: SIE 305. Usually offered: Fall.

### **SIE 477 – Introduction to Biomedical Informatics (3 units)**

Description: Driven by efforts to improve human health and healthcare systems, this course will cover relevant topics at the intersection of people, information, and technology. Specifically, we will survey the field of biomedical informatics that studies the effective uses of biomedical data, information, and knowledge from molecules and cellular processes to individuals and populations, for scientific inquiry, problem solving, and decision making. We will explore foundations and methods from both biomedical and computing perspectives, including hands-on experiences with systems, tools, and technologies in the healthcare system. May be convened with SIE 577. Prerequisite: ECE 175 or CSC 110. Usually offered: Fall.

### **SIE 482 – Lean Engineering (3 units)**

Description: Survey of lean and variability reduction principles as applied to manufacturing and non-manufacturing environments. Prerequisite(s): SIE 305. Usually offered: Spring.

### **SIE 483 -- Computer-Integrated Manufacturing (CIM) Systems (3 units)**

Description: Modern manufacturing systems with emphasis on information requirements and data management. Includes CAD, CAM, CAPP, real-time scheduling, networking, and system justification. May be convened with SIE 583. Prerequisite(s): SIE 383. Usually offered: Fall.

### **SIE 492 – Directed Research (1-3 units)**

Description: Directed research is one of the best ways for an undergraduate to engage in interesting research and get individual guidance from faculty. Contact the faculty member with whom you have interest in working. Usually offered: Fall, Spring, Summer.

### **SIE 493 – Internship (3 units)**

Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment. Faculty Advisor Approval.

### **SIE 496 – Special Topics in Systems and Industrial Engineering (3 units)**

Description: This course is designed to provide a flexible topics course across several domains in the field of Systems Engineering, Industrial Engineering, and Engineering Management. Students will develop and exchange scholarly information in a small group setting. Selected advanced topics in Systems and Industrial Engineering and Operations Research, such as 1) optimization, 2) stochastic systems, 3) systems engineering and design, 4) human cognition systems, and 5) informatics. Repeatability: Course may be repeated for a maximum of 9 units or 3 completions. Prerequisite: SIE 305. Usually offered: Fall, Spring, Summer.

### **SIE 498A – Senior Design Projects I (3 units)**

Teams of students will use material taught in the SIE curriculum to address a customer's needs and help a real-world client design or improve a system. Students will use a system design process, discover system requirements, identify project and technical risks, and develop a project plan and schedule. Students will communicate orally and in writing. A series of design reviews will monitor project goals, schedule, risk and progress. Usually offered: Spring. Department Consent Required.

### **SIE 498B – Senior Design Projects II (3 units)**

Teams of students will use material taught in the SIE curriculum to address a customer's needs and help a real-world client design or improve a system. Students will use a system design process, discover system requirements, identify project and technical risks, and develop a project plan and schedule. Students will communicate orally and in writing. A series of design reviews will monitor project goals, schedule, risk and progress. Continuation of SIE 498A. Usually offered: Fall. Department Consent Required.