SYSTEMS ENGINEERING

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Doctor of Engineering, Systems Engineering and Management (SAM)

The D.E. plan of study with an approved master's degree requires a minimum of 60 credit hours beyond the master's degree, which consists of 39 credit hours of approved coursework and 21 credit hours of Dissertation Research. Specifically, the DE plan of study consists of the following coursework inclusive of appropriate coursework taken as part of a master's degree.

DE Plan of Study		
Core Coursework		
ENM 505	Systems Engineering Fundamentals	3
SYE 551	Systems Architecture and Model-Based Systems Engineering	3
SYE 572	System Simulation	3
SEM 600	Engineering Research Methods	3
SEM 601	Systems Thinking	3
Mathematics Coursework (6 hours)		
ENM 500	Probability & Statistics for Engineers	3
Approved Mathematics Elective		3
Specified Systems Engineering Electives [1]		
Systems Engineering Technical Electives [2]		
Systems Engineering Management Electives [3]		
Systems Engineering Application Area Electives [4]		
Dissertation (21 hours)		
SEM 698	DE Dissertation	

For additional details, see the Doctoral Degree Requirements section on the School of Engineering page and consult with the program director.

1. Approved coursework from any engineering discipline may fulfill the specified systems engineering elective requirements upon approval of the Dissertation Advisory Committee and Director of Systems Engineering Programs.
2. Systems Engineering Technical Electives consist of coursework within a broad range of topics related to holistic system development, such as requirements definition, system architecting, design for..., integration, interfaces, verification, validation, transition, operations, support, etc.
3. Systems Engineering Management Electives consist of coursework relating to systems engineering management competencies, such as project management, decision management, concurrent engineering, enterprise integration, acquisitions, information management, configuration management, and risk management.
4. Systems Engineering Application Area Electives consist of coursework relating to specific systems, such as civil systems, aerospace systems, mechanical systems, chemical systems, electrical systems, etc.

Sponsorship

All candidates for the D.E. in System Engineering and Management degree will require a professional industry/government sponsor to complete the program. The sponsor will serve on the candidate's dissertation advisory committee and as the organizational liaison for the systems engineering practicum to complete the candidate's dissertation.

For additional details regarding sponsorship, consult with the Systems Engineering Program Director.

Regular Admissions for the D.E. in Systems Engineering and Management (with MS)

Applicants shall complete the following in addition to the online graduate application.

1. Official transcripts from all previously attended institutions.
2. Statement of Purpose outlining the applicant's professional goals and commitment to completing degree requirements including procurement of sponsor (two pages maximum)
3. MS in an engineering discipline (e.g. civil, computer, chemical, electrical, industrial, mechanical, etc.; other related STEM majors may be considered on a case by case basis) with a 3.2 GPA
4. Current Resume demonstrating three years of full-time engineering experience
5. One Letter of Recommendation from a supervisor of your full-time engineering experience in your resume
6. Two additional Letters of Recommendation from faculty, supervisors, etc. that can attest to your potential to complete the DE. in Systems Engineering and Management degree requirements
7. International students have additional requirements for admission and immigration purposes, and should review the application information section for international students (https://udayton.edu/apply/international/graduate/) before submitting an application.

Regular Admissions for the D.E. in Systems Engineering and Management (with BS)

Applicants shall complete the following in addition to the online graduate application.

1. Official transcripts from all previously attended institutions.
2. Statement of Purpose outlining the applicant's professional goals and commitment to completing degree requirements including procurement of sponsor (two pages maximum)
3. BS in an engineering discipline (e.g. civil, computer, chemical, electrical, industrial, mechanical, etc.; other related STEM majors may be considered on a case by case basis) with 3.5 GPA
4. Current Resume demonstrating five years of full-time engineering experience
5. One Letter of Recommendation from a supervisor of your full-time engineering experience listed in your resume
6. Two additional Letters of Recommendation from faculty, supervisors, etc. that can attest to your potential to complete the DE. in Systems Engineering and Management degree requirements

7. International students have additional requirements for admission and immigration purposes, and should review the application information section for international students (https://udayton.edu/apply/international/graduate/) before submitting an application.

Conditional Admissions for the D.E. in Systems Engineering and Management

Any applicant not meeting the regular admissions requirements, may be admitted conditionally on a case by case basis.

For additional details regarding admissions, see the Doctoral Degree Requirements section on the School of Engineering webpage and consult with the Systems Engineering Program Director.

Master of Science in Systems Engineering (SYE)

The program of study leading to the Master of Science in Systems Engineering shall include a minimum of 30 semester hours consisting of the following:

Core Coursework (9 hours)		
ENM 505	Systems Engineering Fundamentals	3
SYE 551	Systems Architecture and Model-Based Systems Engineering	3
SYE 572	System Simulation	3
Mathematics Coursework (3 hours)		
ENM 500	Probability & Statistics for Engineers	3
Specified Systems Engineering Electives (18 hours) [1]		
Systems Engineering Technical Electives [2]		6 - 9
Systems Engineering Management Electives [3]		3 - 6
Systems Engineering Application Area Electives [4, 5]		6

For additional details, see the Master's Degree Requirements section on the School of Engineering page and consult with the program director.

1. Approved coursework from any engineering discipline may fulfill the specified systems engineering elective requirements upon approval of the student's advisor and the Director of Systems Engineering Programs.
2. Systems Engineering Technical Electives consist of coursework within a broad range of topics related to holistic system development, such as requirements definition, system architecting, design for..., integration, interfaces, verification, validation, transition, operations, support, etc.
3. Systems Engineering Management Electives consist of coursework relating to systems engineering management competencies, such as project management, decision management, concurrent engineering, enterprise integration, acquisitions, information management, configuration management, and risk management.
4. Systems Engineering Application Area Electives consist of coursework relating to specific systems, such as civil systems, aerospace systems, mechanical systems, chemical systems, electrical systems, etc.
5. Students electing the thesis option will complete 6 hours of SYE 599 in lieu of Systems Engineering Application Area electives, and 3 hours of SEM 600 in lieu of either Systems Engineering Management electives or Systems Engineering Technical electives.

Certificates

Programs of study leading to five graduate-level certificates are also available. Students seeking any of these graduate certificates must apply to and be accepted for admission into a University of Dayton graduate degree program. All Graduate School policies pertaining to admission apply.

Certificate in Foundations of Engineering Management (FEM)

The foundations of Engineering Management Certificate is comprised of three courses – Engineering Economy, Engineering Organizational Development, and Lean Production Systems. These courses serve as the foundation for financial decision making, managing technical personnel and projects, and problem solving and continuous improvement in production systems.

The certificate is comprised of the following three courses:

ENM 530	Engineering Economy	3
ENM 540	Lean Production Systems	3
ENM 582	Engineering Organizational Development	3

Certificate in Modeling & Simulation (MSN)

The Modeling & Simulation certificate is comprised of three courses which will prepare students to formulate and solve mathematical and simulation models in decision making environments.

SYE 521	Introduction to Operations Research	3
SYE 572	System Simulation	3
Choose 1 modeling elective from the following:		3
ENM 565	Reliability Engineering I	
SYE 571	Data Analytics for Systems Engineers	

Certificate in Six Sigma and Operational Excellence (SOE)

Six Sigma is a data-driven approach and methodology for process improvement, and Operational Excellence embraces principles and tools to create an maintain substantial organizational improvements. This graduate level certificate emphasizes essential concepts, practices, and methods for quality improvement, lean management, and effective teamwork. In depth course work in the areas of quality assurance and design & analysis of experiments provide students a rigorous, analytical basis for implementing Lean Six Sigma and Organizational Excellence in practice.

The certificate is comprised of the following three courses:

ENM 564	Lean Six Sigma for Engineers [1]	3
ENM 560	Quality Assurance [1]	3
ENM 561	Design & Analysis of Experiments [1]	3

[1] ENM 500 - Probability & Statistics for Engineers (or equivalent) is a prerequisite for the courses in the Six Sigma and Operational Excellence certificate.

Certificate in Systems Engineering Management (SEM)

Systems engineering is an interdisciplinary approach to design and manage the life cycle of complex systems. The management of such systems must ensure the integration of all aspects of the system which requires knowledge of project management and the ability to make decisions under uncertainty. In addition, managers require a structured approach for defining customer needs and project functionality, documenting requirements, and then proceeding with design synthesis and system validation while considering the system as a whole.

The certificate is comprised of the following three courses:

ENM 505	Systems Engineering Fundamentals	3
ENM 534	Decision Analysis	3
ENM 539	Project Management	3

Certificate in Systems Architecture and Analytics (SAA)

The Systems Architecture & Analytics certificate is comprised of three courses which serve as the foundation for the design, development, and analysis of complex programs, processes or products.

SYE 550	Requirements Engineering	3
SYE 551	Systems Architecture and Model-Based Systems Engineering	3
SYE 571	Data Analytics for Systems Engineers	3
Total Hours		**9**

Engineering Management & Systm Courses

ENM 500. Probability & Statistics for Engineers. 3 Hours
This is an introductory course in the concepts and applications of probability and statistics. Emphasis is on applications and examples that an engineer or analyst would encounter in practice. Probability is presented as the fundamental tool for modeling uncertainty as well as the logical connection between a population of data and its samples. Descriptive statistics are introduced to describe and characterize data. Inferential statistics provide the means of generalizing to a population from a sample, thus enabling solutions and conclusions that otherwise would not be obtained. Modern software provides the leverage to tackle problems of realistic size and complexity. The concepts and methods covered have direct application to forecasting, queuing, inventory, production, scheduling, equipment replacement, reliability, availability, quality control, experimental design, robust engineering, six sigma, and more. Prerequisitie(s): An undergraduate course sequence in calculus.

ENM 503. Engineering Analysis - Methods & Models. 3 Hours
Mathematical methods and models used in the study and solution of decision problems found in engineering and operations research/management science. The methods and models presented build on the student's mathematical foundation and are motivated by their use in solving real-world problems. This is not a concept-theory course but rather a course designed to enhance the modeling and analysis skills of the student. Prerequisite(s): An undergraduate course sequence in calculus.

ENM 505. Systems Engineering Fundamentals. 3 Hours
This course addresses systems engineering concepts, processes, and tools for developing system solutions to meet stakeholder needs. Topics include systems thinking, structure of complex systems, systems lifecycle, system development processes, engineering design and development, systems engineering competencies, and standards of system engineering documentation. The course emphasizes the interdisciplinary and cross-functional nature of systems engineering.

ENM 515. Human Factors Engineering. 3 Hours
Treatment of theory, data, and methods that can be applied to improve the interface between humans and the systems and products that they us. Human capabilities and limitations are studied to support the design of systems and products for safe and efficient use by the human operator.

ENM 516. Human Factors Engineering in Aviation. 3 Hours
Human factors engineering applies principles of human-machine interaction to the design of advanced automated systems. Safety is the most important aspect of automated systems that the study of human factors strives to improve. Human factors in aviation principles can be applied to various engineering domains. Human factors in aviation examines the cognitive and physical characteristics of users and the systems in which they work. Aviation-related human factors topics include aircraft cockpit design and maintenance, and procedures to complex activities. Human factors engineering is the major component of systems design and evaluation, accident investigation and prevention, and training.

ENM 517. Legal Aspects of Engineering. 3 Hours
This is an introductory course which provides the engineer with insight into the areas of law that will impact an engineer’s professional practice. Special emphasis is given to the study of intellectual property including patents, trademarks and copyrights. The course covers points to be considered in entering into contracts, legal options for setting up a business, and the engineer’s legal exposure in the design of products, and legal responsibilities as an engineering employee or employer. Students will have the opportunity to participate in a mock trial through interaction with the law school and local judges.

ENM 520. Engineering Management Fundamentals. 3 Hours
This course provides a fundamental knowledge of engineering management, which is an essential function of any engineering development effort. Topics include leadership, organization management, strategic planning and management, financial resource management, project management, quality management, operations management, supply chain management, management of technology, research, and development, systems engineering, engineering management, and professional codes of conduct and ethics.

ENM 525. Global Supply Chain Management. 3 Hours
This course educates students on the fundamental roles played by supply chain management in the global economy. Students will understand the management of local and global supply chain functions and their impact on industries, customers, and suppliers. Students will learn to optimize supply chain resources to reduce costs and improve revenue. Students will learn to utilize data and contemporary tools to make informed decisions in a global supply chain environment.

ENM 530. Engineering Economy. 3 Hours
This is an introductory course in the concept of time value of money and financial management for engineering managers. The course includes learning curves, cost estimating, managerial accounting, balance sheet and income statement, financial ratios, investment alternatives, depreciation, inflation, capital budgeting and other related topics.

ENM 534. Decision Analysis. 3 Hours
Introduction to decision analysis with applications. Topics explored include structuring decisions under uncertainty, influence diagrams, decision trees, risk analysis, sensitivity analysis, value of information, utility theory, and practical decision making. Prerequisite(s): ENM 500 or equivalent.

ENM 539. Project Management. 3 Hours
This course addresses the concepts, techniques and procedures used to manage engineering programs and projects using an integrated approach for planning, execution, and control. It includes an introduction to the systems approach to project management; project screening and selection; multiple-criteria methods for evaluation; work breakdown structures (WBS) and organization; configuration selection, management and control; project scheduling; project budgets; and resource management. A key goal is to provide the student with sufficient knowledge and tools to confidently manage a project or contribute effectively as a project team member.

ENM 540. Lean Production Systems. 3 Hours
This course includes the principles and current practices using Lean Manufacturing to integrate humans, machines, and materials in producing a marketable product. The use of lean methods to design, develop, and implement the production system are covered. Topics include just-in-time, kaizen, 5s, inventory and production control, and assembly line balancing. The Toyota Production System (TPS) framework will be used as the basis for problem solving and continuous improvement applications for production systems. Graduate standing.

ENM 541. Production Engineering. 3 Hours
Study of the integration of man, machine, and material in producing a marketable product. The use of engineering techniques to design, develop, and implement the production system are covered. Topics include break-even analysis, learning curve theory, forecasting, resource balancing, inventory and production control, facility layout and location, job sequencing and scheduling, and assembly line balancing. Modern production techniques such as just-in-time (JIT), MRP systems flexible manufacturing, and computer-integrated manufacturing are discussed.

ENM 560. Quality Assurance. 3 Hours
Introduction to the fundamental concepts and methods of modern approaches to quality management, quality control, and quality assurance. This course provides an overview of quality management philosophies and implementation strategies. Statistical methods for process control and variety of quality assurance tools are introduced. Prerequisite(s): ENM 500 or equivalent.

ENM 561. Design & Analysis of Experiments. 3 Hours
This course introduces advanced topics in experimental design and analysis, including full and fractional factorial designs, response surface analysis, multiple and partial regression, and correlation. Prerequisite(s): ENM 500 or equivalent.

ENM 563. Advanced Engineering Design. 3 Hours
This graduate-level course seeks to develop in students the ability to integrate dynamic mechanisms (i.e., heat transfer, fluid dynamics, electrical responses, etc.) into system modeling and analyses with uncertainty supporting the verification and validation of systems. Additionally, statistically-based analysis, design, and optimization will be addressed through open-ended problems with explicit considerations of system-level impacts, engineering tradeoffs, and system integration. A course project is required that must demonstrate application of the statistically-based design process. Prerequisite(s): ENM 561 or equivalent; Instructor permission.

ENM 564. Lean Six Sigma for Engineers. 3 Hours
This course will provide a broad exposure to topics in quality improvement that encompass the body of knowledge for Six Sigma Black Belts in both manufacturing and service industries, including hospitals, banks and retailers. Essential concepts, practices, methods and tools for quality improvement, lean management, and effective teamwork are examined, along with the Six Sigma DMAIC problem solving approach. Students will be equipped to help organizations achieve operational excellence by applying what is learned within an improvement project case study. Prerequisite(s): ENM 500.

ENM 565. Reliability Engineering I. 3 Hours
An introduction to reliability engineering concepts and methodology. The reliability, maintainability, and availability of components and multi-component systems are analyzed. Topics include exponential, Weibull, lognormal and normal failure laws, static reliability, hazard rate functions, state dependent failure rate models, redundancy, censoring, empirical models, curve fitting to failure data, and reliability growth testing. Prerequisite(s): ENM 500 or equivalent.

ENM 576. Simulation Modeling for Engineering Managers. 3 Hours
This course is intended to enhance the student's ability to effectively manage simulation projects and use the results to inform and support organizational problem solving and decision making. Students will learn concepts and methods that underlie each major phase of a simulation project while also learning how to build valid models of basic systems. Simulation software will be used to provide students with hand's on experience in designing, building, analyzing and interpreting the results of basic computer simulation experiments and in communicating those results with stakeholders. Prerequisites: ENM 500.

ENM 582. Engineering Organizational Development. 3 Hours
This course addresses individual, group behavior, and organizational design examined within the structure of technical operations, including the systems engineering environment. The objectives are to provide the participants with an understanding of behavioral science and design principles, their effect on organizational performance, and how one applies this science in the management of technical personnel and projects, especially in the systems engineering environment.

ENM 583. Leadership and Engagement for Engineering Diversity. 3 Hours
This course will provide students with an awareness of the barriers, biases and challenges to diversity in engineering, provide strategies that can be used to improve satisfaction in the engineering workplace and in academia; and provide principles and practices that can enhance the students' leadership skills for the engineering workplace.

ENM 585. Engineering Organizational Systems. 3 Hours
Introduction to organizational theory and practice with emphasis on the design of organizational structures for the effective integration of production, research and development, and engineering activities. Special topics include high performing systems, the technical ad-hoc committee, matrix organization, and project management and other current issues.

ENM 587. Leading in Technical Environments. 3 Hours
Understanding and utilizing the keys to leading in technical organizations represents a distinct advantage to individuals and the institutions they serve. Students will be exposed to the underpinning of leadership in engineering environments including tenets,theories,debates, strategies, and innovative techniques. Opportunities to interact with technical leaders from government and industry will be provided. Practical application skills will be developed.

ENM 590. Case Studies in Engineering Management. 3 Hours
This capstone course emphasizes the completion of an engineering management project or study under the direction of a faculty advisor. A well-written report is required. Prerequisite(s): Completion of the engineering management core courses or equivalent.

ENM 595. Special Problems in Engineering Management. 1-3 Hours
SPECIAL PROBLEMS IN ENGINEERING MANAGEMENT This course covers special assignments in engineering management as arranged and approved by the advisor and the program director.

ENM 598. ENM Thesis. 1-6 Hours
Thesis in Engineering Management. Prerequisites: Approval of the thesis prospectus by the student's Advisory Committee and Approval of Program Director.

Systems Engineering Courses

SYE 521. Introduction to Operations Research. 3 Hours
This course covers methods, principles and fundamentals of deterministic and stochastic operations research. Emphasis is on the formulation and solution of mathematical models in decision making environments, the search for optimal solutions to these decisions, and the explicit treatment of uncertainty through the use of probabilistic modeling and statistical analysis. Models include linear and non linear programs, inventory and production models, decision analysis, forecasting. and queuing. Required background in probability theory.

SYE 550. Requirements Engineering. 3 Hours
This course will provide an understanding of the essential concepts, practices, and applications of requirements engineering used to elicit and model requirements for systems. Topics include requirements definitions, classifications, and types, requirements engineering roles, and activities, requirements change management, requirements elicitation techniques, requirements documentation, SysML requirements, requirements modeling and tools, requirements for risk management, traceability, and testing, and requirements frameworks and methods. Prerequisites: ENM 505 (with a minimum grade of a B).

SYE 551. Systems Architecture and Model-Based Systems Engineering. 3 Hours
This course will provide an understanding of the essential concepts, practices, and applications of System Architecture, and how Systems Engineering models can be used to design and deploy a system. The students will be able to apply systems architecture and Model-Based Systems Engineering (MBSE) to model the different types of systems, including: product, service, enterprise and system-of-systems. Prerequisites: ENM 505.

SYE 552. System Verification, Validation and Testing. 3 Hours
This course investigates systems engineering integration, testing, and evaluation methodologies, emphasizing verification, validation, & testing (VVT) practices including development system VVT activities, post-development system VVT activities, non-testing system VVT methods, non-testing system VVT methods, modeling quality, cost, time, and risk, obtaining quality data, and optimizing VVT strategy. Prerequisites: ENM 505 (with a minimum grade of a B).

SYE 553. Risk Analysis. 3 Hours
This course rigorously examines the foundations of engineering risk analysis. Topics include risk analysis methods, risk modeling, trade space analysis, system definition, system structure, failure probability assessment, failure consequence, failure valuation, risk treatment, risk control, risk communication, and risk data. Prerequisites: ENM 500 (with a minimum grade of B).

SYE 571. Data Analytics for Systems Engineers. 3 Hours
Data analytics help to enhance productivity through the application of quantitative and qualitative techniques to extract and categorize data to identify and analyze data patterns. Data analytics demand an integrated set of skills such as statistics, machine learning, and mathematics. This course will introduce students to some of the tools and basic principles of data analytics. Among the techniques, tools, and concepts that students will be introduced to are data collection, analysis of exploratory data, descriptive modeling, predictive modeling, evaluation, and effective communication of analytical outcomes. Prerequisites: ENM 500.

SYE 572. System Simulation. 3 Hours
This course is an introduction to stochastic discrete event simulation of complex systems and human performance. Topics covered include model creation, 2D and 3D animation, the process of generating random numbers and random variables, the analysis of input data, the computer modeling of real systems, validation and variation, and the analysis of simulation output. Emphasis is on modeling real-world systems using modern software. Prerequisites: ENM 500 or equivalent.

SYE 595. Special Topics in Systems Engineering. 3 Hours
To explore a systems engineering competency at an advanced level. Prerequisites: Enrolled in the Master of Science in Systems Engineering (MSSE) Program, Consent of the Instructor and Consent of the Systems Engineering Program Director.

SYE 599. Thesis. 1-6 Hours
Thesis in Systems Engineering.

Systems Engineering & Mgt Courses

SEM 600. Engineering Research Methods. 3 Hours
This course rigorously examines the quantitative and qualitative methods for conducting meaningful inquiry and research. Topics include research ethics, intent, design, methodologies, techniques, formatting, data management, analysis, publication, and presentation utilizing common statistical approaches. Prerequisites: ENM 500 and Graduate standing.

SEM 601. Systems Thinking. 3 Hours
This course rigorously examines systems thinking concepts. Specific topics include system thinking fundamentals, resilience, complexity, root cause, system rules, system dynamics, chaos theory, systems conceptualization, system thresholds, information vitalization, one-stock and two-stock systems, structural predictions, systems change and system scaling. Prerequisites: ENM 505 and Graduate Standing.

SEM 695. Special Topics in Systems Engineering. 1-6 Hours
This course investigates special topics in systems engineering practice. Prerequisites: Enrolled in a Graduate Systems Engineering Program, Consent of the Instructor or Consent of the Systems Engineering Program Director.

SEM 698. DE Dissertation. 1-15 Hours
Research of an applied problem regarding systems engineering practice under the guidance of the student's major professor. Prerequisites: SYE 600 and Enrolled in Doctor of Engineering in Systems Engineering and Management Program, Approval of the dissertation prospectus by the student's Advisory Committee or Systems Engineering Program Director Approval.