

# ENSE - SYSTEMS ENGINEERING

---

## **ENSE621 Systems Engineering Concepts and Processes: A Model-Based Approach (3 Credits)**

An INCOSE-oriented introduction to model-based systems engineering. Provides an overview of systems engineering concepts, processes and methods, with a particular focus on: the development of stakeholder and system requirements; characteristics of well-written requirements; the use of SysML software tools to develop of system- and element-level architectures; and the relationship between requirements and architecture. Architecture-related topics include specification and visualization of system attributes, behavior, and interfaces. Other topics include acquisition and development life cycle models; operational concepts and use cases; requirements and design traceability; analysis, modeling and simulation; systems engineering management; risk management; configuration management; systems-of-systems; and system complexity. The course includes a class project in which teams of 3-5 students use SysML to develop stakeholder requirements, system requirements, and a logical system architecture for an engineered system of interest to them and then perform a design trade-off analysis for some aspect of the system.

**Restriction:** Permission of ENGR-Institute for Systems Research.

**Credit Only Granted for:** ENPM641 or ENSE621.

## **ENSE622 System Trade-off Analysis, Modeling, and Simulation (3 Credits)**

This course continues the model-based approach to systems engineering by introducing students to a variety of mathematical modeling and simulation techniques used to perform system performance, optimization, and trade-off analyses. Topics include: linear and integer programming; state machine models of finite state machines; development of simple intelligent agents; modeling Markov processes; queueing theory; multi-objective trade-off analyses; decision trees; stochastic (Monte Carlo) simulation, linear regression, some predictive analytic techniques; and an introduction to control theory. Mathematical models and simulations are developed and executed using MATLAB. The course includes a class project in which students solve a problem of interest to them using one or more of techniques addressed in class.

**Prerequisite:** Permission of ENGR-Institute for Systems Research; and ENSE621.

**Recommended:** Familiarity with calculus, probability, linear algebra, differential equations, & computer programming recommended.

**Credit Only Granted for:** ENPM642 or ENSE622.

## **ENSE623 System Development, Verification, and Validation (3 Credits)**

This course completes the ENSE621, ENSE622 sequence. It covers system simulation development and a variety of verification and validation topics. It addresses development testing and operational testing; test methodologies; the planning of test programs and Test and Evaluation Master Plans (TEMPs); the planning and execution of tests; and the writing of test plans and test reports. Topics include verification methods; specification-based testing; test verification matrices; model-based verification; model checking and other formal approaches to verification; design of experiments; performance testing; reliability testing; usability/human factors testing; and other types of testing. The course includes a class project in which teams of 3-5 students: develop requirements for a simulation that supports a system analysis of interest (the user need); develop the simulation (in MATLAB); verify that it meets its requirements; and validate that it may be used to support the analysis of interest.

**Prerequisite:** Permission of ENGR-Institute for Systems Research; and ENSE622.

**Credit Only Granted for:** ENPM643 or ENSE623.

## **ENSE624 Human Factors in Systems Engineering (3 Credits)**

This course covers the general principles of human factors, or ergonomics as it is sometimes called. Human Factors (HF) is an interdisciplinary approach for dealing with issues related to people in systems. It focuses on consideration of the characteristics of human beings in the design of systems and devices of all kinds. It is concerned with the assignment of appropriate functions for humans and machines, whether the people serve as operators, maintainers, or users of the system or device. The goal of HF is to achieve compatibility in the design of interactive systems of people, machines, and environments to ensure their effectiveness, safety and ease of use.

**Restriction:** Permission of ENGR-Institute for Systems Research.

**Credit Only Granted for:** ENPM644 or ENSE624.

## **ENSE626 System Life Cycle Analysis and Risk Management (3 Credits)**

This course covers topics related to estimating the costs and risks incurred through the lifetimes of projects, products and systems. In addition, treatment is given to methods that determine the drivers of costs and risks and facilitate determination of the most effective alternatives to reducing them. Also covered, are relevant analytic tools from probability and statistics and also important managerial and organizational concepts. Extensive use is made of case studies and examples from industry and government.

**Prerequisite:** Permission of ENGR-Institute for Systems Research.

## **ENSE627 Systems Quality and Robustness Analysis (3 Credits)**

This course covers systems engineering approaches for creating optimal and robust engineering systems and for quality assurance. It provides an overview of the important tools for quality analysis and quality management of engineering systems. These tools are commonly used in companies and organizations. Focus is placed on the Baldrige National Quality Program, ISO 9000 certification, six-sigma systems, and Deming total quality management to examine how high quality standards are sustained and customer requirements and satisfactions are ensured. The Taguchi method for robust analysis and design is covered and applied to case studies. Issues of flexible design over the system life cycle are addressed. Statistical process control, international standards for sampling, and design experimentation are also studied.

**Restriction:** Permission of ENGR-Institute for Systems Research.

**Credit Only Granted for:** ENPM647 or ENSE627.

**ENSE698 Special Topics in Systems Engineering (3 Credits)**

**Prerequisite:** ENSE621; and permission of ENGR-Institute for Systems Research.

**Repeatable to:** 6 credits if content differs.

**ENSE699 Directed Study in Systems Engineering (1-3 Credits)**

Directed study in Systems Engineering.

**Prerequisite:** ENSE621, ENSE622, and ENSE623.

**Repeatable to:** 3 credits if content differs.

**ENSE799 Systems Engineering Thesis (1-6 Credits)**

The application of systems engineering concepts, principles, and theories will be applied to the Master's Thesis project. Project/thesis work will be defined and selected early in student's program and supervised by a university faculty mentor.

**Prerequisite:** Permission of ENGR-Institute for Systems Research; and ENSE621; and must have 6 additional credits totaling 9 credit hours.

**Repeatable to:** 6 credits.