

# ENSE - SYSTEMS ENGINEERING

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## **ENSE621 Systems Concepts, Issues, and Processes (3 Credits)**

An introduction to the professional and academic aspects of systems engineering. Topics include: systems engineering activities, opportunities and drivers; case studies of systems failures; models of system lifecycle development; introduction to model-based systems engineering; representations for system structure, system behavior, system interfaces and systems integration; reactive (even-driven) systems, systems-of-systems, measures of system complexity; visual modeling of engineering systems with UML and SysML; simplified procedures for engineering optimization and tradeoff analysis. Software tools for visual modeling of systems with UML and SysML. Students will complete a project for the front-end development of an engineering system using UML/SysML.

**Restriction:** Permission of ENGR-Institute for Systems Research. Also offered as: ENPM641.

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

## **ENSE622 Systems Requirements, Design and Trade-Off Analysis (3 Credits)**

This course builds on material covered in ENSE621/ENPM641, emphasizing the topics of requirements engineering, system-level design and trade-off analysis. Topics include: requirements engineering processes; representation and organization of requirements; implementation and applications of traceability; capabilities of commercial requirements; engineering software; system-level design; design structure matrices; principles of modular design; component- and interface-based design methods; multi-objective optimization-based design and tradeoff; approaches to system redesign in response to changes in requirements, reliability, trade-off analysis, and optimization-based design. Students will complete a project focussing on the development of requirements and their traceability to the system-level design of an engineering system.

**Prerequisite:** ENPM641 and ENSE621; or permission of ENGR-Institute for Systems Research. Also offered as: ENPM642.

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

## **ENSE623 Systems Projects, Validation and Verification (3 Credits)**

This course builds on material covered in ENSE621/ENPM641 and ENSE622/ENPM642. Topics will cover established and emerging approaches to system validation and verification including; inspection, testing, and traceability; writing validation and verification plans; formal approaches to system validation and verification; specification-based testing; role of logic in system validation and verification; automation models of computation, timed automation; model-based design and model checking for reactive systems. Students will be introduced to software tools for specification-based testing, model-based testing, model-based design and model checking. Students will work in teams on semester-long projects in systems engineering design and formal approaches to system validation and verification.

**Prerequisite:** ENSE622 and ENPM642; and permission of ENGR-Institute for Systems Research. Also offered as: ENPM643.

**Credit Only Granted for:** ENPM643, ENSE610, 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. Also offered as: ENPM644.

**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. Also offered as: ENPM646.

## **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. Also offered as: ENPM647.

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

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

### **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.