ASE 6002 QSY • Systems Design and Analysis • Fall 2026

Instructor

- **Lead Instructor**: Doug Bodner, Ph.D., P.E.
- **Mentors:** TBD

Overview

1. **Course description**: Modern systems underpin today's society, ranging from defense and national security, to transportation, to energy, to consumer products, and more. This course provides a theoretical foundation for the development and use of models in the design of such systems. Models include both decision models and analysis models. The focus is on value-driven design, which emphasizes the selection of alternatives that maximize stakeholder preferences. The course leverages state-of-the-art model-based systems engineering methods and tools to enable modern design practice using the theoretical foundation provided.
2. **Course pre-requisite**: ASE 6001 – Fundamentals of Modern Systems Engineering
3. **Other pre-requisites**: Basic probability and statistics from undergraduate engineering and basic programming/software skills
4. **Delivery**: This is an online course with asynchronous video lectures plus synchronous office hours and three synchronous live sessions.
5. **Learning environment**: This class is a learning environment, both inside and outside the live sessions. Learning will occur through a mix of online lectures, online discussion forums, individual assignments, live sessions, group exercises, online office hours and most importantly a team project. You should absolutely ask questions if you are unclear about something.
6. **Course outcomes**: Upon successful completion of this course, you will be able to:
    - Analyze system elements using systems thinking to relate design variables to performance attributes and performance attributes to objectives, characterizing first order and interaction effects
    - Frame design decisions in terms of objectives, requirements, alternatives, outcomes, and preferences
    - Model design preferences including risk and time preferences
    - Distinguish between architectural design and detailed sizing design
    - Link design problem elements in a computational/optimization/simulation framework
    - Elicit uncertainty characterizations, update them as needed with new information using Bayesian procedures, and incorporate them into models
    - Perform statistical analysis for uncertainty when suitable datasets are available

- Evaluate design alternatives by conducting simulation-based optimization studies
- Demonstrate proficiency in use of state-of-the-art MBSE tools when conducting design studies
- Critically evaluate analysis results in the presence of uncertainty
- Recognize and discuss the trade-offs between the costs and value of different simulation-based design processes

Course Materials and Resources

1. **Required textbook**: *Fundamentals of Decision Making for Engineering Design and Systems Engineering*, by George A. Hazelrigg. ISBN 978-0-984997602.
2. **Optional textbook**: *Introduction to Probability, Statistics, and Random Processes*, by H. Pishro-Nik. ISBN 978-0990637202. Available at www.probabilitycourse.com/ (free).
3. **Additional reading**: Articles and other additional reading will be posted to Canvas.
4. **Software**: We will use ModelCenter®, Excel® and JMP® (all available via VLAB) and Capella™. You may elect to use additional software for your team project.
5. **Modules:** The course is arranged into weekly units with material organized via Modules on Canvas (lectures, assignments, plus other course material).

Assignments and Grading

1. **Grade component weights**:
    - Team assignments (60%)
        - TA-1: Systems Thinking and Conceptual Design 0%
        - TA-2: Quantitative System Design Model 20%
        - TA-3: Quantitative System Design Model with Uncertainty 20%
        - TA-4: Optimized System Design under Uncertainty 20%
    - Individual assignments (35%)
        - IA-1: Designing Systems with ModelCenter 5%
        - IA-2. Architectural Design 10%
        - IA-3: Design under Different Data Scenarios 10%
        - IA-4: Staged Decisions under Uncertainty and Risk 10%
    - Participation (5%)
        - Live sessions, group exercises and quizzes 5%
2. **Overall course grade**: The course will be graded based on a straight scale – A (100% to 90%), B (89% to 80%), C (79% to 70%), D (69% to 60%), and F (below 60%).
3. **Exams**: There are no exams in this course.
4. **Team assignments**: The class features a team-based design project using ModelCenter. The team project is intended to assess your ability to synthesize and apply concepts and methods taught in class to real-world situations, and to communicate your results effectively. The project will be conducted in four phases,

each with a team assignment deliverable. An ungraded project selection deliverable will kick off the project. The final deliverable will leverage the previous ones into a complete simulation-based design study. Teams should consist of 4-5 students mixing different skillsets. You are encouraged to select a design problem that is of interest to your team, and that is in a domain in which your team has knowledge and expertise. There will be peer evaluations conducted within each team to help ensure that each team member contributes approximately equally to the overall effort. Peer evaluations may be used to adjust individual grades on team assignments.

5. **Individual assignments**: Individual assignments are intended to assess your individual understanding of important course concepts. There are four individual assignments.
6. **Participation**: Participation credit is provided for attendance and discussion at live sessions, plus contributions to the group exercises done at these events.
7. **Electronic submission**: All assignments will be submitted electronically on Canvas. It is highly recommended that you submit the assignment before the deadline and then check to make sure that the correct files(s) have been submitted, and that the submission is complete. A link to a document on a third-party platform is not an acceptable submission.
8. **Late assignments**: Late assignment submissions will be offered only if you have a valid reason (severe illness, severe illness or death of an immediate family member, serious accident, important religious holiday, work-related requirement, or Institute-approved activities with proper documentation). Such reasons must be submitted as early as possible, preferably well before the due date
9. **Grade appeals**: Grade appeals should be presented in writing within one week after the graded assignments are returned. A grade appeal may result in the entire exam or assignment being regraded.

Topics and Tentative Schedule

1. The course covers the following topics.
    - **Module 0**: Course Overview and Introduction
    - **Module 1**: Introduction to System Design
    - **Module 2**: The Design Decision Problem
    - **Module 3**: Understanding System Value
    - **Module 4**: Cost Estimation and Modeling
    - **Module 5**: Demand Modeling
    - **Module 6**: Probability Basics
    - **Module 7**: Uncertainty in Design
    - **Module 8**: Applying Probability
    - **Module 9**: Limited Data and Bayesian Updates
    - **Module 10**: Risk Preferences Under Uncertainty

- **Module 11**: Computational Methods for Design Assessment
- **Module 12**: Solving the Design Problem
- **Module 13**: Heuristic Approaches to Design

2. The schedule of topics will be posted on Canvas prior to the first day of class.

Academic Integrity

1. **General**: The Honor Code is taken seriously in this class. You should familiarize yourself with its rules and procedures.
2. **Collaboration**: The team project and associated team assignments will involve substantial collaboration among team members, so your collaboration skills are very important. The individual assignments do not involve collaboration. However, questions about them may be posted on the class discussion forum.

Administrative Policies and Procedures

1. **General**: The Student-Faculty Expectations Agreement provides a framework for creating an atmosphere of mutual respect in the classroom. You are encouraged to review it.
2. **Attendance**: Attendance at live sessions is required. Each team will generally have one or more slots each week during team assignment office hours. All team members should attend.
3. **Time zone**: Unless otherwise stated, all times are assumed to be expressed using Eastern USA Time (ET).
4. **Communication forums**: Announcements will be posted on Canvas, and Canvas Discussions will be used to answer questions of a general nature. You are encouraged to post questions about class material and assignments on Discussions for class discussion.
5. **Email communications**: You should address all emails about the course to the instructor or a mentor. Be sure to include the course number in the subject field (ASE 6002). Many procedural questions are already answered in the syllabus, so please check the syllabus beforehand.
6. **Website outages**: You should download lecture videos and slides and other material from Canvas well in advance of assignment due dates. OIT often does upgrades or service activities, and you do not want these items to be unavailable the night before a deadline.

Student Resources and Support

1. **Academic resources:** You are encouraged to use campus academic support resources (Academic Success & Advising) for tutoring and coaching if needed.
2. **Non-academic resources:** Your well-being is important. If you find yourself with a serious non-academic issue, campus resources include the Center for Mental Health

Care & Resources, Health Services and Student Life. Additionally, you are highly encouraged to be vaccinated against the flu and Covid-19.

3. **Accommodations for individuals with disabilities**: The Office of Disability Services assists with accommodation for individuals with disabilities. If you need accommodation, please contact the instructor as soon as possible to discuss your individual needs.