SYS 510: Tools and Methodologies for Designing Systems

Course Information
Term: Fall 2024
MWF 3:30 – 4:20 pm Eastern time
WANG 2555
We will use Brightspace

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Course Description

Introduction to modeling tools and methods for designing engineered systems. Topics include: defining the design problem; defining and validating stakeholders' and system requirements; discrete mathematics for system modeling; defining and modeling system operational scenarios; the system development life cycle; defining and modeling functional, physical, and allocated architectures; evaluating and modeling the tradeoffs between alternative architectures; and defining the system qualification process.

Prerequisites

Students are assumed to have graduate standing and to have completed some college-level mathematics, i.e., calculus and perhaps some probability. A **Windows operating system** is necessary to use the modeling tools.

Course Goals

The purpose of the course is to:

1. emphasize patterns of systems thinking,
2. introduce systems design processes and methods,
3. introduce theory for model-based systems engineering, and
4. provide practice in using model-based systems engineering tools.

Learning Objectives

Upon completion of the course, students will be able to

1. apply the discrete mathematics concepts of set theory, relations and functions, and graph theory to characterize and analyze the functional and structural aspects of models for designing engineered systems,
2. critique different approaches for system development life cycles and for systems design processes,
3. define an engineered system's context,
4. define and critique a functional model of a system development life cycle using a model-based systems engineering tool,
5. define and critique models of the functional architecture of an engineered system using a model-based systems engineering tool,
6. define a system's stakeholders and define formal system I/O requirements,
7. define models of the physical architecture of an engineered system using a model-based systems engineering tool,
8. apply an option creation technique to generate alternative physical architectures
9. define an allocated architecture of an engineered system using a model-based systems engineering tool,
10. define the relationship of stakeholders' requirements to design trade-off objectives,
11. flow down a formal system I/O requirement,
12. understand alternative graphical modeling approaches for data modeling, process modeling, and behavior modeling
13. define and model uncertainty, value, and risk preference for evaluating design tradeoffs between alternative system architectures,
14. review and evaluate models of the interfaces of an engineered system using a model-based systems engineering tool,
15. critique a functional model of early validation using a model-based systems engineering tool, and
16. define a qualification requirement for a formal system I/O requirement

System Certificate

This course completes one of the requirements of the Graduate Certificate in Systems. For more information about the Systems Certificate, visit https://www.purdue.edu/collaboratory/. Ask your advisor for more information and how to apply.

Piazza Discussion Site

- ***Do*** use Piazza for any query that other students might also be interested in
  - ***Do not*** use e-mail
    - Anonymous posting to Piazza will be allowed
    - Excessive trolling will result in anonymous posting privilege for ***all*** students to be disallowed
- ***Do*** use e-mail for queries that are personal
  - Requests for regrading
  - Extraordinary circumstances that might require delaying due date for homework
- Students are expected to assist each other on Piazza
  - Course is graded using an absolute scale and not on a curve
  - Assisting each other can improve each other's level of learning and grades
  - ***Will not*** result in lowering anyone's grade
- Instructors' responses on Piazza
  - May be quite brief and may not fully answer a question to your satisfaction
    - You may need to interact with instructor and TAs one-on-one to be satisfied
  - A timer delay of ***24 hours*** has been set to allow instructors to hold off on answering student questions immediately, thereby encouraging other students to answer questions. Only instructors can see the timer.
  - Will ***not*** respond to questions about a homework assignment 24 hours prior to the due date
    - The instructors will not be pulling all-nighters on Piazza to support those who do not start working on homework immediately when assigned

Course Requirements

Assignments

There will be 38 homework assignments that are comprised of exercises that are assigned during the class lecture session when the relevant background material is being covered.

There is a **Microsoft Excel Calendar File** posted to Brightspace that serves as a master schedule for the homework and reading assignments that is updated regularly. Use it to locate the date of the lecture when homework was assigned and to cross-reference assignments with exercises. This file is stored on the Microsoft OneDrive server that is

accessed using your Purdue CareerID and Microsoft authentication. If you have issues with access to this file, please contact the ITaP Customer Service Center.

By Phone: +1-765-494-4000
By Email: itap@purdue.edu

Do not wait until near the due date to begin completing homework assignments. Instead, begin working on them immediately after the material is covered in the lecture.

Homework assignments are to be completed as individuals and must be submitted via the class Brightspace site 10 minutes prior to class on the day that they are due. This allows the instructor the option to discuss solutions during the lecture the day that the homework is due. The default time zone in Brightspace is Eastern time, because West Lafayette is in the U.S. Eastern time zone. You can set the preferred time zone in your Brightspace profile, which will show all of your times with dates in your preferred time zone.

The homework assignments are set up as quizzes in Brightspace. Students may submit an unlimited number of attempts for a quiz prior to the due date. Note that once an attempt is submitted, students will not be able to see the answers that they have submitted. Students will not be able to access quizzes after the due date.

Students may assist each other, but must submit their own work. The course is graded using an absolute scale and not on a curve; therefore, assisting each other can improve each other's level of learning and grades. It will not result
in lowering the grade for those students who ultimately submit their own work. There are multiple ways to detect that a student has copied a file from another student and submitted it as their own work, so don't even try it.

Students will be asked to solve problems related to sets, graphs, and probability and decision trees, and there should be adequate coverage of these topics in the lectures and readings to allow students to succeed.

Missed or Late Work
The instructor will not accept late work.
The time from when the homework is assigned to when it is due will be at least one week. In extraordinary circumstances such as natural disasters, grief/bereavement, military service, jury duty, parenting leave, and debilitating illness, the instructor will accept late work. Students may also request special consideration to allow them to participate in holidays or days of religious observance, and in these cases, they will be expected to make their needs known in advance and be flexible in arranging alternative times to complete any assignments they might miss.
For late homework to be considered for grading, the student must provide the instructor with a written request with justification as to why the situation is extraordinary or is related to participating in holidays or days of religious observance. Requests must be consistent with any notifications issued by the Dean of Students (https://www.purdue.edu/advocacy/students/absences.html).

Grading
Homework assignments will be given a numerical score (0 – 100) based on a unique scoring scheme for each assignment that is posted to Brightspace.

If students have a concern about grading on an assignment, they should bring it to the attention of the instructor. Requests for reconsideration or re-grading must be made within one week of when the assignments are returned to students.

To calculate your letter grade, calculate your average score across all assignments and use the table below. There is a Final Grade Calculated item in Brightspace that performs this calculation based on homework graded to date. It is an estimate of what your final grade would be if the course ended as of the last graded homework.

Numerical to letter conversion for grades	
Score	Grade
87.5 to 100%	A
62.5 to 87.49%	B
37.5 to 62.49%	C
12.5 to 37.49%	D
0 to 12.49%	F

Required Text

Buede, Dennis M. and William D. Miller. 2016. *The Engineering Design of Systems: Models and Methods,* ***Third Edition***. Hoboken, NJ: Wiley.

- *Not* the Second Edition (2009)
- *Not* the First Edition (2000)

Available as a pdf book online at the Purdue library site (login required)
https://ebookcentral.proquest.com/lib/purdue/detail.action?pq-origsite=primo&docID=7104359

Class Schedule

This is the order that material from the textbook will be covered:

Chapter 1 Introduction to Systems Engineering
Chapter 2 Overview of the Systems Engineering Design Process
Chapter 3 Modeling and SysML Modeling
Chapter 4 Discrete Mathematics: Sets, Relations, and Functions
Chapter 5 Graphs and Directed Graphs (Digraphs)
Chapter 6 Requirements and Defining the Design Problem
Chapter 7 Functional Architecture Development
Chapter 8 Physical Architecture Development
Chapter 9 Allocated Architecture Development
Chapter 14 Decision Analysis for Design Trades

Chapter 10 Interface Design
Chapter 11 Integration and Qualification
Chapter 13 Graphical Modeling Techniques
Chapter 12 A Complete Exercise of the Systems Engineering Process
Chapter 16 The Science and Analysis of Systems
Chapter 15 The Value of Systems Engineering

Classroom Etiquette

Students who must arrive late or leave early may do so without disrupting the ability of the other students to see and hear the lecture.

All cell phones and computers must be silenced during class.

University Policies, Accessibility Information, and Student Help and Success

The class Brightspace site has links to detailed information on these topics. Please become familiar with this information as part of working collaboratively with other students, faculty, and staff to create an ethical and safe environment in which scholarship may flourish.