SYS 510: Tools and Methodologies for Designing Systems

Course Information
Term: Fall 2021
MWF 12:30 – 1:20 pm Eastern time
WANG 2579
We will use Brightspace

Professor Information
C. Robert Kenley, PhD, ESEP, INCOSE Fellow
Associate Professor of Engineering Practice
School of Industrial Engineering
Office: GRIS 370
Phone: +1 765 494 5160
E-mail: kenley@purdue.edu
Web site: http://web.ics.purdue.edu/~ckenley/
Webex: https://purdue.webex.com/meet/ckenley
Office Hours: For a more seamless meeting process, create an Exchange meeting request by accessing your purdue.edu account via a browser at https://outlook.office365.com or via the Outlook desktop application. Use the Meeting Planning and Scheduling Assistant capabilities to find an open time slot for your meeting request.

Teaching Assistant Information
TBD
Graduate Student
TBD
E-mail: tbd@purdue.edu
Webex: https://purdue-student.webex.com/join/tbd
Office Hours: TBD in GRIS 157 TBD
TBD via Webex

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 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.
        - Teaching Assistant will be primary responder
        - Professor will weigh in for unresolved items
    - Will ***not*** respond to questions about a homework assignment after 12:01 am U.S. Eastern Time ***on the day*** it is due

Course Requirements

Assignments

Homework assignments will be 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.

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.

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 extreme circumstances, the instructor might accept late work with an appropriate penalty to the score. These circumstances most likely would be those that lead to a student filing to receive a grade of Incomplete in the class. For late homework to be considered for grading, the student must provide the instructor a written request with justification as to why the circumstance is extreme.

Grading

Homework assignments will be given a numerical score (0 – 100) based on a unique rubric 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?docID=4391537

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 12 A Complete Exercise of the Systems Engineering Process
Chapter 13 Graphical Modeling Techniques
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.