

# SYS 510: Tools and Methodologies for Designing Systems

## **Course Information**

Term: Fall 2018  
MWF 9:30 – 10:20  
WALC 3090  
We will use Blackboard

## **Instructor 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  
Web: <http://web.ics.purdue.edu/~ckenley/>

Office Hours: Check the calendar link at Professor Kenley's web site and send an e-mail request that suggests a couple of times to meet

## 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 engineering 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 engineering 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

## Course Requirements

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 Blackboard that serves as a master schedule for all class sessions and assignments that is updated regularly.

**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 Blackboard site 10 minutes prior to class on the day that they are due.

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.

## Required Texts

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

## 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

## Policies

### General Course Policies

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.

### Grading

Homework assignments will given a numerical score (0 – 4) based on a unique rubric for each assignment that is posted to Blackboard.

If students have a concern about a grading, 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 an approximate estimate of your letter grade, calculate your average score and round it to the nearest whole number: A = 4, B = 3, C =2, D =1, and F = 0. There is an Approximate Estimated Grade item on the “My Grades” page of Blackboard that performs this calculation. This is an unofficial grade based on

homework graded to date. It is an "approximation" of what your final grade would be if the course ended as of the last graded homework.

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.

### **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.

### **Academic Dishonesty**

*Two considerations:*

1. *Don't cheat*
2. *There is an anonymous means to report suspected cheating*

*For more information, visit the following web site:*

<http://www.purdue.edu/odos/osrr/academic-integrity/index.html>

### **Attendance**

*Students are expected to be present for every meeting of the classes in which they are enrolled. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts or absences can be anticipated, such as for many University sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible...For unanticipated or emergency absences when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, or by contacting the main office that offers the course. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, the student or the student's representative should contact the Office of the Dean of Students.*

### **Grief Absence Policy for Students**

*Purdue University recognizes that a time of bereavement is very difficult for a student. The University therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). GAPS Policy: Students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the learning outcomes for missed assignments or assessments in the event of the death of a member of the student's family.*

### **Use of Copyrighted Materials**

*Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.*

*Notes taken in class are, however, generally considered to be “derivative works” of the instructor’s presentations and materials, and they are thus subject to the instructor’s copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course.*

### **Violent Behavior Policy**

*Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity.*

### **CAPS Information**

*Purdue University is committed to advancing the mental health and wellbeing of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and <http://www.purdue.edu/caps/> during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.*

### **Students with Disabilities**

*Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: [drc@purdue.edu](mailto:drc@purdue.edu) or by phone: 765-494-1247.*

### **Emergencies**

*In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.*

**Diversity and Inclusion**

*Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue's nondiscrimination policy can be found at:*

[http://www.purdue.edu/purdue/ea\\_eou\\_statement.html](http://www.purdue.edu/purdue/ea_eou_statement.html).