▫Northwestern University
IEMS 490 System Engineering and Architecture
Spring 2016

PRELIMINARY

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COURSE SYLLABUS
IEMS 490 System Engineering and Architecture

Textbook:

System Analysis, Design, and Development, Concepts, Principles, and Practices.
Charles S. Wasson 1st Edition.

The text will be used as a basis for discussion but will not be followed rigidly. Examinations and exercises will be based on material covered in class.

Purpose:
The objective of this course is to develop the ability to think about complex problems from a systems point of view. The course will enable the student to understand how to identify architecture and requirements, understand how to compare different product architectures and requirements, and finally understand how to break down a complex problem into manageable subsystems and define the architecture and requirements for the entire system as well as the subcomponents.

Philosophy:
The course philosophy is to provide the students with a toolkit that, combined with their existing knowledge, will give them improved ability to think about complex systems. Much of Systems Engineering and Architecture is a set of techniques that the student can learn and apply, so much of the class will take the form of introducing general concepts then going through practical and realistic examples of how those concepts can be applied.

Objectives:
Upon completion of the class, the student will be able to:
1. Define Systems Engineering and Architecture as disciplines and differentiate between them
2. Recognize when each discipline should be applied and explain the value it would provide in that situation
3. Apply the techniques of systems engineering to identify and document project requirements
4. Apply architectural decomposition techniques to a complex project

Syllabus

Week 1: System Analysis Concepts

The following subtopics will be covered on an overview basis: Definitions of Systems Engineering and Architecture, definition of what a system actually is, identification of the characteristics of a system, identification of stakeholders and how to determine their demands on a system, determining how stakeholders will decide if the system is acceptable to them, and definition of the lifecycle of a product.

Homework: Read Text Chapter 1-7.
Exercise: identification of examples of systems, characteristics, stakeholders

Week 2: The Architecture Task
This week will focus on what constitutes architecture. The idea of system of systems will be discussed. A way of thinking about a system that identifies the environment and high level structure of a system, the "System of Interest" idea, is introduced. We consider what the interfaces of a system are, who uses it, and how it interacts with its environment.

Homework: Read Text Chapter 8-17
Exercise: for several examples to be provided document the SOI concept

Week 3: What Constitutes a System?

This week we will inquire into what a "system" actually is. There are models that describe how systems operate, what their inputs and outputs look like, and what is required to support a system. All of these will help define and understand the concept of a system. Models for how to determine what a system can do and what states it can be in are helpful in determining how we talk about and define a system.

Homework: Read Chapter 18-23 of text
Exercise: Create models of several systems using techniques discussed

Week 4: The SE Process
This week we discuss what the SE process typically looks like. We will consider where SE fits in the larger view of product realization. SE receives input from upstream "suppliers" and provides input to downstream "customers". This unit explores these relationships.

Homework: Read Chapters 24-28 of text
Exercise: show process for several examples of projects

Week 5: Requirements

Requirements are the artifact produced by the System Engineering task. This week we will focus on how to identify them, how to break them down, and how to document them. We will review typical sources of requirements such as regulatory and standards. Types of requirements that are commonly seen are discussed, such as Functional, Performance, Regulatory, Reliability, Security, and Administrative. Separation of "what" from "how" is fundamental and is discussed in detail. Tools in common use (Doors, Caliber) are introduced.

Homework: Read Chapters 28-33 text

MID TERM EXAM Chapters 1 through 33 of text, with emphasis on discussion areas in class.

Week 6: System Development

Continuing the discussion of requirements development, this week we look at what objectives are appropriate, and how do we capture them? We consider a wide set of design objectives that should be considered when identifying system requirements. Transitioning to the Architecture task, we consider equivalent questions as to how we create a systems architecture, and what some of the common architectural models are that are used. A high-level architecture is often necessary to develop a complete set of requirements, so in this unit we consider some of the common choices such as centralized versus decentralized, Client-Server, redundant and fault-tolerant.

Homework: Read Chapters 34-38 of text
Exercise: Identify requirements for cases of projects
document architecture for these projects

Project selection for Final

Week 7: Component Selection and Human Factors

There are numerous influences on requirements and architecture that must be taken into account. Standards often exist that mandate certain characteristics. Legal/regulatory considerations often dictate what a system can and cannot do and how it must be done. Component availability determines what parts are available for building a system, and the constraints of each component must be taken into account. We consider the qualifications of components and how these they are chosen.

Homework: Read chapters 39-46 of text
Exercise: Requirements and architecture considering constraints

Week 8: Modeling and Performance

Many systems need to be modeled, as the performance of the system is often a critical factor in its usability and suitability for the intended task. This week will look at what

metrics are often of interest and consider basic modeling techniques for performance, reliability, and availability. Performance in particular has several measures of interest that may need to be modeled in different ways; we explore some of the techniques for doing so.

Homework: read chapters 47-52 of text
Exercise: create performance models for several examples – capacity, availability

Week 9: System Verification

Once the system is complete we need to determine how to verify that the system does what we planned it to do and that it meets the needs of the user. We will discuss how requirements are linked to test and how requirements are validated with real system usage, The process for deploying a system and making it operational is considered.

Homework: Read Chapters 52-57 of text.
Exercise: show examples of how to verify examples of projects

Week 10: In Class Exercises

This session will consider several case studies. These will be class participation exercises where the requirements, architecture, and verification processes will be used by the class to analyze a complex problem and determine a feasible solution. This will parallel what the student will do on their own in the final examination.

Homework: Read case studies (to be provided)

Week 11: Take Home Final due

Course grading

Midterm examination	20% (open book, open notes)
Requirements exercises	20%
Architecture exercises	20%
In class participation	10% based on student participation in class
Final Examination	30% (Take home final)

Take Home Final: Will be a multi-week project to define requirements and architecture for a significant project of interest to the student. Selection of target project will be worked with the instructor. Output to be complete requirements specification and architecture decomposition of a nontrivial project, documented in sufficient detail to be developed and tested.