Syllabus for ENES 489P: Hands-on Systems Engineering

(9/10/17 Draft)

Semester: Fall 2017
Class Day: Tuesday
Class Time: 5:00 pm – 6:15 pm
Class Location: CSI 2120
Lab Day: Thursday
Lab Time: 3:30 pm – 6:30 pm
Lab Location: AVW 1442
Instructor: Dr. John MacCarthy
Instructor Office: AVW 2175
Phone: 5-4419
Email: jmaccart@umd.edu
Office Hours: By Appointment

Course Description:

This course provides an INCOSE-oriented introduction to model-based systems engineering. It provides an overview of systems engineering concepts, processes and methods, with a particular focus on: the development of stakeholder and system requirements; characteristics of well-written requirements; the use of SysML software tools to develop of system- and element-level architectures; and the relationship between requirements and architecture. Architecture-related topics include specification and visualization of system attributes, behavior, and interfaces. Other topics include acquisition and development life cycle models; operational concepts and use cases; requirements and design traceability; analysis, modeling and simulation; systems engineering management; risk management; configuration management; systems-of-systems; and system complexity. Student teams develop stakeholder and system requirements and a system- and element-level architecture for an engineering system of interest using SySML.

Required Texts:

  - Available from INCOSE website at no cost for UMD students (download instructions will be provided by e-mail)
  - Available as an e-Book from the engineering library (download instructions will be provided by e-mail)

Required Software:

- Cameo System Modeler (e-mail will be sent prior to class on how to download this).
Course Outline:

Class 1.1 (8/29): Course Introduction
- Assignment(s) Due: None
- Reading Due:
  - SEHB TOC & Chapter 2
  - K&S Chapters 1 & 2
  - HW 1 Personal Information Template
- Topics:
  - Course Introduction and Syllabus
  - Course Project, Homework, & Presentations
  - Course Proposals & Team Formation
  - What is a System?
  - Key System Concepts
  - K&S on Systems and Systems Engineering

Class 1.2 (8/31): Introduction to SE & Systems Modeling
- Assignment(s) Due: Final HW 1 (Personal Information)
- Reading Due:
  - SEHB TOC & Chapters 2 & 3
  - K&S Chapter 3
  - HW 3 Project Proposal Template & Example
- Topics:
  - What is Systems Thinking?
  - What are some SE-Related Domains?
  - What is a Systems Engineer?
  - What is INCOSE?
  - What is Systems Engineering?
  - The Systems Engineering Technical Processes
  - Why do Systems Engineering?
  - Introduction to Systems Modeling
  - K&S on System Development
  - The Project Proposal
Class 2.1 (9/5): Life Cycle Models & Systems Engineering Management I

- Assignment(s) Due:
- Reading Due:
  - SEHB Chapters 3
  - K&S Chapter 4
  - HW 4 SEMP Template
- Topics:
  - Life Cycle Models (LCMs) as a Context for SE
  - The INCOSE Acquisition LCM
  - Acquisition LCM Activities and Products
  - The V Development LCM
  - Development LCM Activities and Products
  - Other LCMs
  - Systems Engineering Management and Project Management
  - K&S on SE Management

Class 2.2 (9/7): Systems Engineering Management II

- Assignment(s) Due: Final HW 2 (Myers Briggs)
- Reading Due:
  - SEHB Chapters 3, 5, & 6
  - K&S Chapter 4
  - HW 4 SEMP Template
- Topics:
  - SE Management and Project Management
  - The INCOSE Technical Management Processes (Ch 5)
  - INCOSE Project Planning Process (Ch 5.1)
  - INCOSE Project Assessment and Control Process (Ch 5.2)
  - K&S on SE Management (Ch 4)
  - Overview of the Acquisition Process & SEHB Agreement Processes (Ch 6)
  - Systems Engineering Planning
  - The Systems Engineering Management Plan (SEMP)
  - Organizational Structures & Teams
  - Myers-Briggs & Managing Personality Conflicts
Class 3.1 (9/12): Systems Analysis, Measurement, and Modeling & Simulation

- **Assignment(s) Due:** Draft HW 3 (Project Proposal)
- **Reading Due:**
  - SEHB Chapters 4.6, 5.3, 5.4, 5.7, and 9.1
  - K&S Chapters 4.4 & 14
- **Topics**
  - INCOSE System Analysis Process
  - INCOSE Measurement Process
  - INCOSE Measurement Process (MOEs, KPPs, MOPs, & TPMs)
  - Systems Analysis
  - System Performance Analysis & Response Models
  - Modeling and Simulation Heuristics

Class 3.2 (9/14): Model-Based Systems Engineering, SysML, and The OOEM

- **Assignment(s) Due:** None
- **Reading Due:**
  - SEHB Chapters 4.4, 9.1-9.4
  - Delligatti Chapters 1, 2
- **Topics:**
  - Model-Based Systems Engineering
  - INCOSE Architecture Definition Process
  - INCOSE Cross-Cutting Methods
  - Architecture Frameworks & Modeling Languages
  - Function-Based Systems Engineering
  - Object-Oriented Systems Engineering
  - The Object Oriented Systems Engineering Method (OOSEM)
  - The Systems Modeling Language (SysML)
  - MBSE, Requirements, Architecture, SysML & the OOSEM

Class 4.1 (9/19): The Concept Stage: Stakeholders’ Needs & Requirements

- **Assignment(s) Due:** Draft HW 4 (Project SEMP)
- **Reading Due:**
  - SEHB Chapters 4.1, 4.2, & 10
  - K&S Chapter 5
  - HW 5 System Concept Description Template & Example
- **Topics:**
  - The Concept Stage and Concept Stage Products
  - The System Concept Description & Context-Level Architecture
  - Overview of SEHB Business or Mission Analysis Process
  - Overview of SEHB Stakeholder Needs and Requirements Definition Process
  - K&S on Needs Analysis
Specialty Engineering Considerations and Stakeholder Requirements

Class/Lab 4.2 (9/21): Introduction to Cameo Systems Modeler & Package Diagrams
- Assignment(s) Due: None
- Reading Due:
  - Delligatti Chapters 1, 2, & 10
  - HW 5 System Concept Description Template & Example
- Topics:
  - Cameo System Modeler
  - Package Diagrams
  - System Capabilities & MOEs

Class 5.1 (9/26): Requirements Definition, Requirements Documents, Writing Requirements, & Requirements Databases
- Assignment(s) Due: None
- Reading Due:
  - SEHB Chapter 4.3
  - Guide for Writing Requirements Summary Sheet
- Topics:
  - INCOSE Requirements Definition Process (Ch 4.3)
  - Levels & Types of Requirements
  - Requirements Documents and Standards
  - Writing Requirements.
  - Requirements Management and the Requirements Database

Class/Lab 5.2 (9/28): Use Case Diagrams, Use Case Narratives, & Blocks and Block Definition Diagrams
- Assignment(s) Due: None
- Reading Due:
  - Delligatti Chapters 3 & 5
  - Use Case Narrative Template & Example
  - HW 5 System Concept Description Template & Example
- Topics:
  - Blocks and Block Definition Diagrams (BDDs) & Generating BDDs (Ch 3)
  - Levels and Types of BDDs (Context, Interface Flow, System/Element)
  - Use Case Diagrams (UCDs), Use Case Narratives, & Generating UCDs (Ch 5)
  - Use Case Narratives
Class 6.1 (10/3):  The Concept Stage & The Stakeholders’ Requirements Document, Requirements Diagrams, & Requirements Analysis

- **Assignment(s) Due:** None
- **Reading Due:**
  - K&S Chapters 6 & 7
  - Delligatti Chapter 11
  - HW 6 Stakeholder Requirements Document Template & Example
- **Topics:**
  - More on the Concept Stage Phases (K&S Chs 6 & 7)
  - The Stakeholders’ Requirements Document
  - Stakeholder Requirements & Context-Level Architecture
  - SysML Requirements Diagrams & Requirements Tables (Delligatti, Ch 11)
  - Generating Requirements Documents from Requirements Databases
  - Systems Requirements Analysis
    - Requirements Identification & Clarification
    - Requirements Quality Verification

Class/Lab 6.2 (10/5):  Blocks, Block Definition Diagrams, & Internal Block Diagrams

- **Assignment(s) Due:**
  - Final HW 3 (Project Proposal)
  - Final HW 4 (Project SEMP)
  - Draft 1 of HW 5 (System Concept Description & Context-Level Architecture)
- **Reading Due:** Delligatti Chapters 4 & 11
- **Topics:**
  - The Context Diagram
  - Internal Block Diagrams (IBDs), Flow BDDs, and Generating IBDs (Ch 4)
  - Stakeholder Performance Requirements (MOE, MOSs, & KPPs)
  - SysML Requirements Diagrams & Requirements Tables (Ch 11)
Class 7.1 (10/10): Development Stage: System-Level Architecture & The System Requirements Document I

- **Assignment(s) Due:** None
- **Reading Due:**
  - K&S Chapter 7 & 8
  - SEHB 5.7
  - HW 7 System-Level Architecture Template & Example
  - HW 8 System Requirements Document Template & Example
- **Topics:**
  - The Development Stage
  - The System Requirements and Architecture Phase
  - K&S on the “Concept Definition” and “Advance Development” Phases (K&S Ch 7 & 8)
  - System-Level Architecture
  - The System Requirements Document
  - System Performance Metrics (KPPs, KSAs, TPMs, and other MOPs)

Class/Lab 7.2 (10/12): Activity Diagrams, Sequence Diagrams, & State Diagrams

- **Assignment(s) Due:**
  - Draft 2 of HW 5 (System Concept Description)
  - Draft HW 6 (Stakeholder Requirements Document)
- **Reading Due:** Delligatti Chapters 6, 7, & 8
- **Topics:**
  - Activity Diagrams (ADs), Use Case Narratives & Generating ADs
  - Sequence Diagrams
  - State Machine Diagrams

Class 8.1 (10/17): Midterm Exam (Week 1-6)

Class/Lab 8.2 (10/19): Development Stage: System-Level Architecture & Requirements Document II

- **Assignment(s) Due:** Final HW 5 (System Concept Description)
- **Reading Due:**
  - HW 7 System-Level Architecture Template & Example
  - HW 8 System Requirements Document Template & Example
  - Example Requirements Trace Matrix (RTM), Requirements Verification Matrix (RVM), and Requirements Allocation Matrix (RAM)
- **Topics:**
  - System-Level Architecture
  - The SRD RTM, RVM, & RAM
Class 9.1 (10/24): Development Stage: Preliminary Design and Critical Design
- Assignment(s) Due: None
- Reading Due:
  - SEHB 4.5
  - K&S Chapter 9
- Topics:
  - The System Concept Review (SE Management, Stakeholder Requirements, & Context-Level Architecture)
  - The V LCM Preliminary Design Phase
  - Element Requirements
  - Element-Level Architecture
  - The V LCM Critical Design Phase
  - SEHB Design Definition Process (SEHB 4.5)
  - K&S on the Engineering Design Phase

Class/Lab 9.2 (10/26): Proposal Presentations
- Assignment(s) Due:
  - Final Pres 1 (Proposal Presentation)
  - Final HW 6 (Stakeholder Requirements Document)
- Reading Due: None
- Topics: Project Proposal

Class 10.1 (10/31): Development Stage: System Design
- Assignment(s) Due: None
- Reading Due: None
- Topics:
  - General Design Principles
  - K&S on Software Development
  - Introduction Software Engineering and Design
  - Design Verification

Class/Lab 10.2 (11/2): Performance Analysis & RAM Analysis
- Assignment(s) Due:
  - Final HW 7 (System-Level Architecture)
  - Draft HW 8 (System Requirements Document)
- Reading Due: None
- Topics:
  - Performance Analysis
  - Communications System Analysis
  - RAM Analysis
Class 11.1 (11/7): Decision and Risk Management & Analysis
- Assignment(s) Due: None
- Reading Due: None
- Topics:
  - INCOSE Decision Management Process
  - INCOSE Risk Management Process
  - K&S on Risk Management
  - Example Risk Analysis

Class/Lab 11.2 (11/9): Trade-off Analysis
- Assignment(s) Due: Final HW 9 (System Performance Analysis)
- Reading Due: None
- Topics:
  - Pareto Analysis
  - MAUF Analysis

Class 12.1 (11/14): Configuration Management
- Assignment(s) Due: None
- Reading Due:
  - SEHB Ch 5.5, 9.5, & 9.6
  - K&S Ch 9.6
- Topics:
  - Configuration Management (SEHB 5.5)
  - Interface Management (SEHB 9.6)

Class/Lab 12.2 (11/16): Design Conference Presentation Preparation
- Assignment(s) Due: Final HW 10 (System Trade-off Analysis)
- Reading Due: None
- Topics: Design Conference Presentation

- Assignment(s) Due: None
- Reading Due: None
  - SEHB Chapters 4.7-4.11 and 9.5
  - K&S Chapters 8.5, 10, and 13
- Topics:
  - Prototyping (SEHB 9.5)
  - System Implementation, Integration, & Verification Processes (SEHB 4.7-4.9)
  - System Transition and Validation Processes (SEHB 4.7-4.9)
  - K&S on Integration and Testing
  - Introduction to System and Element Testing

Class 13.2 (11/23): Thanksgiving – No Lab


- Assignment(s) Due: HW 11 (Project System Analysis)
- Reading Due:
  - SEHB Chapters 4.12-4.14, 8, 9.8-9.9, & 10.6
  - K&S Chapters 11 and 12
- Topics:
  - SEHB Production, Operations, Maintenance, and Disposal Processes (SEHB 4.12-4.14)
  - K&S on Production, Operations, & Support

Class/Lab 14.2 (11/30): Design Conference Dry Run

- Assignment(s) Due: Draft Pres 2 (Design Conference Presentation)
- Reading Due: None
- Topics: Design Conference

Class 15.1 (12/5): Tailoring the SE Processes, Lean SE, & Agile SE

- Assignment(s) Due: None
- Reading Due:
  - SEHB Chapters 4.12-4.14, 8, 9.8-9.9, & 10.6
  - K&S Chapters 11 and 12
- Topics
  - Overview of the SEHB Tailoring Processes (SEHB 8)
  - Lean and Agile Systems Engineering (SEHB 9.8-9.9)
  - Final Exam Review
Class/Lab 15.2 (12/7): Design Conference
  • Assignment(s) Due: Final Pres 2 (Design Conference Presentation)
  • Reading Due: None
  • Topics: Design Conference

12/14: Assignment(s) Due: HW 12 (Teammate Assessment)

Class 16.1 (12/19): Final Exam (7-15)