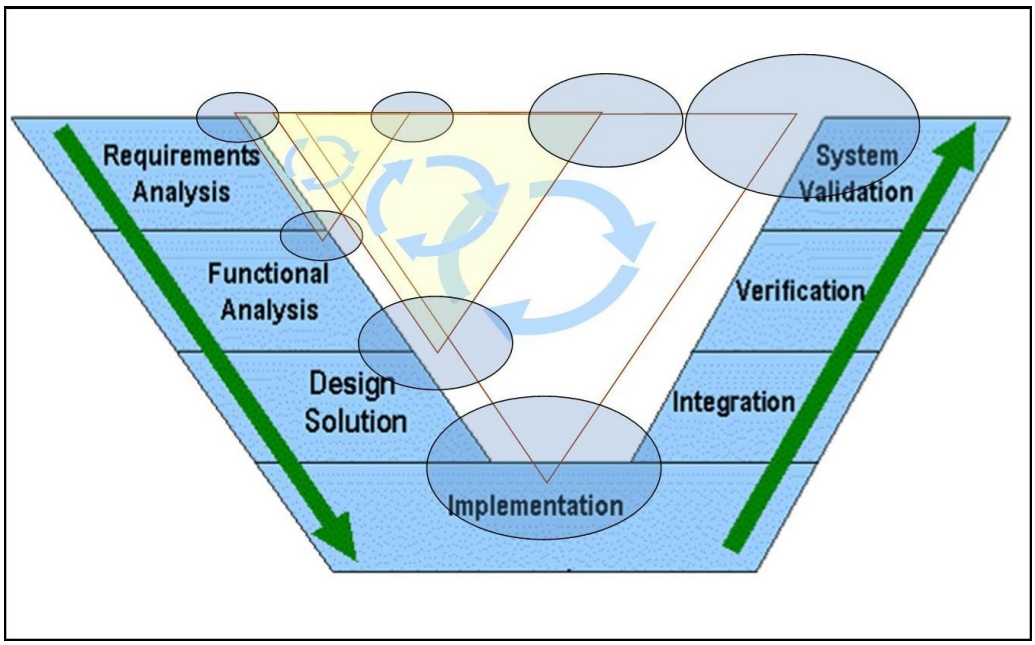
UNIVERSITY
OF
SOUTHERN CALIFORNIA

Syllabus
Systems Engineering Theory & Practice
SAE 541



Jim Hines

Spring 2019

UNIVERSTY OF SOUTHERN CALIFORNIA

COURSE SYLLABUS

SYSTEMS ENGINEERING THEORY AND PRACTICE (SAE 541)

Instructor: Jim Hines; Phone: 562-714-4326; Email: jhines@usc.edu
Office Hours: 2:30 PM Thursday or By Appointment
TA: Parisa Pouya; Phone: 213-880-1954.; Email: pouya@usc.edu
Class: Thursday 03:30 PM-06:10 PM OHE 120

Course Description:

Systems engineering is an evolving discipline that applies an inter-disciplinary problem-solving approach across the entire technical effort whether military, industrial, commercial or civil systems and system of systems. The discipline is mandated on all military and civil programs. Over the past few decades, especially due to the evolution digital computers and software, the complexity and interconnectiveness of systems for a great variety of applications has overwhelmed previous technical & management processes. This complexity has resulted in developmental failures, cost overruns, schedule slippage, stakeholder dissatisfaction and environmental disasters.

This course will acquaint the student with both the theory and practice of the discipline of systems engineering and the systems engineering design approach to devise a system solution which meet customer/stakeholder objectives optimally within available resources. The course will discuss solving open-ended problems, employing creativity, formulating of problem and need statements and requirements, examining alternative solutions, utilizing concurrent engineering design, and considering a variety of realistic constraints, such as economic (business case) factors, safety, reliability, aesthetics, ethics, social impact, production, and operations

Among the topics to be covered in the class are:

- Perspectives of Systems, System Types and the System Architecture
- Systems, Critical, Design Thinking
- Value of Systems Engineering
- System Acquisition & Life Cycle Models
- Systems Engineering Process Standards
- General Statement of the Problem or Need
- Requirements & Functional (Logical) Analysis
- Capability Documents & Specifications
- Synthesis & Architecting
- Systems Analysis **(**Trade Studies and Other Decision Methodologies) & Affordability
- Verification, Validation, and Test
- Product Realization (Program Execution) including Implementation, Integration & Transition and Interface Analysis
- Design for Specialties (Reliability, Availability, Maintainability, Safety, Human Systems Integration, Operations & Interoperability, Manufacturing and Production, Supportability, Sustainability & Logistics)
- Next Steps in Systems Engineering

Course Learning Objectives:

- Demonstrate an understanding of basic system and systems engineering concepts and terms
- Apply systems engineering as a problem solving process / approach and its relationship to program life cycle
- Recognize systems engineering technical processes and their interactions
  - Construct various systems engineering artifacts
  - Justify the application of systems engineering principles in the development of artifacts.
  - Assess useful theories, models, techniques and tools
  - Employ design for operational feasibility (specialty engineering) concepts
- Solve as a team an open – ended problem, synthesize a system "architectural" solution and formulate a set of requirements, which can form the basis of a system specification so it could be designed and built.
- Develop student's "team and soft skills".

Course Highlights:

There will be:

1) Lectures
2) Exercises (individual or team-based)
3) Team Presentations
4) Quizzes (Pre and Post) or Midterm & Final

These activities are to provide a valuable learning experience by demonstrating your knowledge, comprehension, application, analysis, synthesis, and evaluation of the subject material. You will be expected to apply systems thinking and utilize the systems engineering process during the course.

As in the "real world" of systems engineering involves teamwork. As a result, we will be forming teams for working on selected Exercises to solve a system problem of the team's choice. Each team is required to demonstrate that they can perform selected Exercises. Each team will be required to present results on an assigned basis.

Submit all assignments submitted through DEN Desire2Learn for this class, unless otherwise noted by the instructor or teaching assistant.

Proprietary Information is not permitted nor to be discussed in this class.

We encourage students during the course to ask for help and use of the DEN provided discussion board resource since others might have same inquiry about course materials, etc. or call or e-mail us. The usual turnaround time for discussion board or emails is less than 24 hours. If you do not hear from us within that timeframe, please send us a reminder. Always include the TA in any email sent to the instructor

Grading: USC Grading Policies shall be followed.

	Activity Weighting Factor		
Quizzes	10 post quizzes	50%	150 points
	(10 pre-quizzes; 10 post-quizzes, 15 points total per quiz for right answers.)		
Exercises	10 exercises / 3 team presentations/ peer evaluation	50%	150 points
	(10 points/ 10 exercises, 10 points/ 3 team presentations, 20 points/ peer evaluation)		
	Total	100%	300 points

All assignments will be submitted through DEN for this class, unless otherwise noted by the instructor or teaching assistant. Please use Microsoft Word or PowerPoint or PDF documents for your submitted assignments.

Unless otherwise noted by the instructor or teaching assistant, exercises and quizzes is due at 9:00 PM PT on the day before the lecture (Wednesday) following the week that it is assigned. Please consult teaching assistant or instructor before the day the exercises & quizzes are due if there are special circumstances that prevent you from submitting exercises or quizzes on time.

Academic Integrity Statement: The School of Engineering adheres to the University's policies and procedures governing academic integrity as described in USC Campus. Students are expected to be aware of and to observe the academic integrity standards described in USC Campus, and to expect those standards to be enforced in this course: scampus.usc.edu

Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213)740-0776.

Classroom Courtesies: Standard classroom courtesies are expected from students attending the lectures on campus. Cell phone use and side conversations among students are not respectfully. These practices are distracting to the on-going presentations. These courtesies also extend to DEN students who should mute their phones during lecture when not speaking to the class.

Planned Course Schedule (Subject to Change based on Course Progression)

Class Session	Date	Topics	Readings, INCOSE Handbook
1	1/10/2019	Course Overview, Introductions, Course Questions, Administrative Items.	Chapter 1: Systems Engineering Course Scope, Course Questions
2	1/18/2019	Systems Engineering Introduction: Definitions, System, System of Systems; Critical, System, & Design Thinking; SE Characteristics and Discipline; Value of Systems Engineering; System/Traditional Engineer/Project Management Roles.	Chapters 2, 9.7: Systems Engineering Handbook Scope, Systems Engineering Overview; Integrated Product & Process Development
3	1/25/2019	Program Life Cycle & Standards: Technical Reviews & Baselines; SE Life Cycle Development Models, Process Standards, Lessons Learned, and Tailoring	Chapters 3, 8: Generic Life Cycle Stages; Tailoring and Application od Systems Engineering
4	2/7/2019	Understanding the Problem: Stakeholder, User, Business Needs Quality Function Deployment (QFD)	Chapters 4.1, 4.2, 4.3: Business or Mission Analysis Process; Stakeholder Needs and Requirement Definition Process;
5	2/14/2019	Requirements Analysis & Validation: Types, Writing Requirements, Assessments, & Validation, Specifciations	Chapter 4.3, 9.5: System Requirements Definition Process, Prototyping
6	2/21/2019	Functional Analysis & Allocation / Synthesis: Function, Functional Context Diagram, Operations Concept (OpsCon), Functional Flow Block Diagrams, Functional Allocation; Elements, Design Matrices, Physical Context Diagram, Hierarchy, Schematic Block Diagram, Modularity, 3 Cs Guidance	Chapter 5.7, 9.3: Measurement Process, Cross-Cutting Technical Methods – Functions Based Systems Engineering Method
7	2/28/2019	Architecting: States & Modes, Definitions, Heuristics, Complexity,Architectural Considerations, Architecture Description, Framework, Robust, Resilient & Agile Architectures	Chapter 4.4 Architecture Definition Process
8	3/7/2019	Model- Based Systems Engineering, System Design Considerations & Interface Analysis: COTS, Open Modular Systems Approach, Interface Definition, Types, N-squared Diagram, Interface Specification	Chapters 4.5, 9.2, 9.4, 9.6; Design Definition Process, Interface Management, Model – Based Systems Engineering; Object – Oriented Systems Engineering
9	3/21/2019	Systems Analysis: Effectiveness Analysis, Affordability & Cost as an Independent Variable (CAIV), Pugh matrix, Trade Studies, Utility Analyses, & AHP	Chapter 4.6, 5.3, 9.1, 10.1: System Analysis Process; Decision Management Process; Modeling & Simulation; Affordability
10	3/28/2019	Systems (Product) Realization, Integration & Evaluation: Terminology, Product Integration Goals & Practices; Challenges, Verification, VCRM, & Product Validation.	Chapters 4.7, 4.8, 4.9, & 4.11: Implementation, Integration, Verification, & Product Validation Processes
11	4/4/2019	Test & Evaluation/ Transition/ Design for Operational Feasibility or Specialty Engineering: Types of Tests, Open Systems Testing, Test Requirement Sheet, Testability; Transition; Engineering Specialties, Types, Reliability, Safety & Health Hazards	Chapters 4.9, 4.10, 10.8, 10.9: Verification, Reliability, System Safety
12	4/11/22019	Specialty Engineering: Availability, Maintainability, Operation, Supportability, Sustainment & Logistics, Human Systems Integration, Interoperability, System Security & Information Assurance, Manufacturing and Production, Disposal	Chapters 10, 4.12, 4.13, 4.14: Specialty Engineering Activities, Operations, Maintenance, and Disposal Processes
13	4/18/2019	Risk & Opportunity: Definitions, Process, Risk Matrix, Identification, Writing Risk Statements, Analyzing, Handling, Control,	Chapter 5.4, Risk Management Process
14	4/25.2019	Next Steps Systems Engineering: Trends, Challenges, Reflection Presentations	Application of Systems Engineering

Exercises:

- Assigned weekly corresponding to lecture material.
- Due following Wednesday at 9:00 PM Pacific time. Please consult with the Instructor or teaching assistant before exercises or quizzes are due if there are any reason that prevent you from submitting them on time.
- Late exercises will be graded before class at 3:30 PM Pacific time will be accepted and graded with 10% penalty. [Rationale: Motivate an early input to provide a brief opportunity to review submissions prior to lecture and comment, but with small penalty.]

Text: International Council of Systems Engineering, *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, 4th Edition, 2015. Hardcopy from Wiley, or online from INCOSE.org (electronic version is free with student membership or for USC students); instructions for USC student download is provided in D2L SAE 541.

Partial List of References:

1. ISO/IEC/IEEE 26702: Systems Engineering - Application and management of the systems engineering process.
2. Defense Acquisition University, Systems Engineering Fundamentals, 2001. Free government PDF document online: http://spacese.spacegrant.org/SEModules/Reference%20Docs/DAU_SE_Fundamentals.pdf
3. Defense Acquisition University Guidebook, Chapter 3, Systems Engineering 11/2017 https://www.dau.mil/tools/dag/Pages/DAG-Page-Viewer.aspx?source=https://www.dau.mil/guidebooks/Shared%20Documents%20HTML/Chapter%203%20Systems%20Engineering.aspx
4. NASA Systems Engineering Handbook, NASA/SP-2007-6105 Rev1, December 2007 nasa.gov/sites/default/files/atoms/files/nasa_systems_engineering_handbook_0.pdf
5. Expanded Guidance for NASA Systems Engineering (Volumes 1 and 2), NASA/SP2016-6105-SUPPL https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170007238.pdf https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170007239.pdf
6. Guide to the Systems Engineering Body of Knowledge (SEBoK) v 1.6 http://sebokwiki.org/wiki/Guide_to_the_Systems_Engineering_Body_of_Knowledge_(SEBoK) http://sebokwiki.org/wiki/Download_SEBoK_PDF
7. Systems Engineering for Intelligent Transportation Systems, 2007 http://ops.fhwa.dot.gov/publications/seitsguide/seguide.pdf
8. FAA Systems Engineering Manual , Version 1.1, 2015
9. Systems Engineering and Analysis, 5th Edition, Blanchard and Fabrycky, Prentice Hall, 2011.
10. Managing Complex Technical Projects", Faulconbridge and Ryan, Artech House, 2002

Administrative Resources:

1. DEN Instructional Support Center: dennotes@usc.edu, (213) 740-9356
2. USC Distance Education Network (DEN): http://gapp.usc.edu/den
3. DEN Exams and Proctoring, https://gapp.usc.edu/graduate-programs/den/technical-support/homework-and-exams (213) 821-3136 or denexam@usc.edu
4. Technical Support, Online Services, Webcast Problems, Software Questions or General Technical Questions (213) 821-1321 or webclass@usc.edu
5. USC DEN Desire2Learn: https://www.uscden.net/

6. BlueJeans conferencing tool available for DEN@Viterbi Faculty and Students
   http://uscviterbi.bluejeans.com

Statement on Academic Conduct and Support Systems

Academic Conduct: Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/scampus-part-b/. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS): (213) 740-7711 – 24/7 on call Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline: 1-800-273-8255 Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship & Sexual Violence Prevention Services (RSVP): (213) 740-4900 - 24/7 on call Free and confidential therapy services, workshops, and training for situations related to gender-based harm. https://engemannshc.usc.edu/rsvp/ Sexual Assault Resource Center For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX compliance: (213) 740-5086 Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support: Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

Student Support & Advocacy: (213) 821-4710 Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC: https://diversity.usc.edu/ Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students