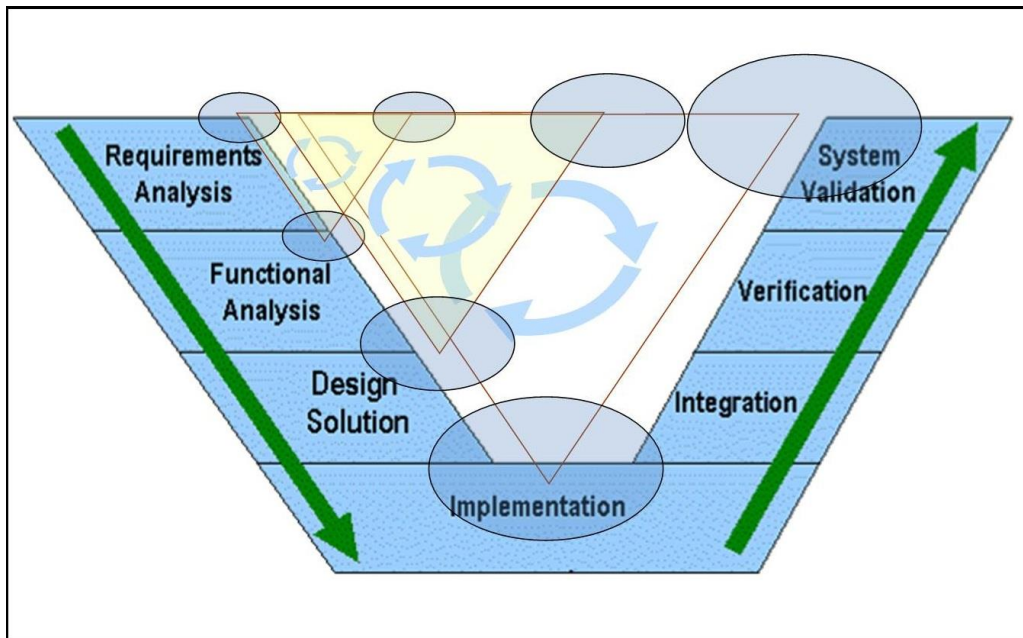


**UNIVERSITY
OF
SOUTHERN CALIFORNIA**

**Syllabus
Systems Engineering Theory & Practice
SAE 541**



**Jim Hines
Summer 2018**

UNIVERSITY 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: 3:30 PM Wednesday or By Appointment

TA: TBD; Phone: TBD; Email: TBD

Class: Tuesday 03:30 PM-06:40 PM OHE 132

Course Description:

Systems engineering is an evolving, inter-disciplinary approach and means to enable the realization of successful systems whether military, industrial, commercial or civil systems. The discipline is mandated on all military and civil programs. Over the past few decades, systems and system of systems have grown in complexity overwhelmed previous technical & management processes resulting 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 systems engineering discipline and the systems engineering design approach to devise a system (architectural) solution, which meets customer/stakeholder objectives optimally within available resources. Although systems engineering involves both technical and management processes, this course concentrates on technical processes. The course discuss solving open-ended technical design 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, operations and support.

Among the topics 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
- 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 as employed across a program life cycle.
- Recognize systems engineering as an alternative way of thinking.
- Explain the systems engineering technical processes and their interactions both distinct and integrated
 - 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 with Case Studies
- 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 are to apply systems thinking and utilize the systems engineering process (es) during the course.

As in the “real world” of systems, engineering involves teamwork. As a result, we will be forming teams of 4 – 6 students for working on selected exercises to solve a 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

Course Grading: USC Grading Policies followed.

| Activity Weighting Factor | | |
|---|-------|-----------------|
| Quizzes or Midterm & Final: | 50% | 150 points |
| Ten post quizzes or Midterm & Final (Ten pre-quizzes; Ten post-quizzes, 15 points total per quiz for right answers.) | | |
| Exercises: | | |
| Ten exercises / four team presentations/ peer evaluation | 50% | 150 points |
| (100 points, 10 points/ Ten exercises; 24 points, 6 points/ Four team presentations, 26 points/ peer evaluation) | | |
| | Total | 100% 300 points |

All assignments submitted through DEN for this class, unless otherwise noted by the instructor or teaching assistant. Pre-quizzes or tests allow learners to see what they already know and do not know; help with learning and instructor class feedback. Quizzes or tests will be multiple choice.

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) and Exercises |
|---------------|-----------|---|--|
| 1 | 5/22/2018 | Course Overview & Questions; Introduction to Systems Engineering | Chapters 1, 2, 9.7: Systems Engineering Scope & Overview; Integrated Product & Process Development |
| 2 | 5/29/2018 | System Thinking; SE Characteristics and Discipline; Value of Systems Engineering; Roles. Program Life Cycle & Standards | Chapters 3, 8: Generic Life Cycle Stages; Tailoring and Application of Systems Engineering |
| 3 | 6/5/2018 | Systems Life Cycle, Development Models & Process Standards, Technical Reviews, Understanding the Problem & Needs | Chapters 4.1, 4.2: Business or Mission Analysis Process; Stakeholder Needs and Requirement Definition Process; Exercise #1: Systems Engineering; Teams Formed |
| 4 | 6/12/2018 | Requirements Analysis & Validation; Specifications | Chapter 4.3: System Requirements Definition Process; Exercise #2 Understanding the Problem / Need |
| 5 | 6/19/2018 | Functional Analysis & Allocation / Synthesis | Chapters 5.7, 9.3: Measurement Process, Cross-Cutting Technical Methods – Functions Based Systems Engineering Method; Exercise #3: OFD & Writing Requirements |
| 6 | 6/26/2018 | Architecting | Chapters 4.4, 9.2, 9.4: Architecture Definition Process, Model – Based Systems Engineering; Object – Oriented Systems Engineering; Exercise #4: Functional (Logical) Analysis |
| 7 | 7/3/2018 | System Design Considerations; Interfaces; and Systems Analysis | Chapters 4.5, 4.6, 9.1, 9.5, 9.6: Design Definition Process, Interface Management, Systems Analysis, Prototyping, Modeling & Simulation; Exercise #5: Architecting & Synthesis |
| 8 | 7/10/2018 | Systems (Product) Realization: Implementation & Integration | Chapters 4.7, 4.8: Implementation & Integration Processes; Exercise #6: System Design and Interface Analysis |
| 9 | 7/17/2017 | Evaluation: Verification & Validation; & Transition; | Chapters 4.9, 4.10 & 4.11: Verification, Validation & Transition Processes; Exercise #7: System Analysis |
| 10 | 7/24/2018 | Design for Operational Feasibility or Specialty Engineering | Chapters 10, 4.12, 4.13, 4.14: Specialty Engineering Activities, Operations, Maintenance, and Disposal Processes; Exercise #8: Verification & Test |
| 11 | 7/31/2018 | Risk & Opportunity Analysis | Chapter 5.4; Risk Management Process; Application of Systems Engineering; Exercise #9: Specialty Engineering |
| 12 | 8/7/2018 | Team Presentations; Challenges & Next Steps | Exercise #10: Risk & Opportunity Analysis |

Exercises:

- Assigned weekly corresponding to lecture material.
- Due following Monday 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://space.se.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/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
https://sep.faa.gov/policy_and_guidance/main
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.uscdcn.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