UNIVERSTY OF SOUTHERN CALIFORNIAD
COURSE SYLLABUS

SAE 541
SYSTEMS ENGINEERING THEORY AND PRACTICE

Class lectures:	**Thursdays: 3:30–6:10 p.m. PT, OHE 120 or via DEN**
Instructor:	Dr. Robert Minnichelli
Phone (mobile):	310-291-8380
	(urgent use only – use DEN Discussion Board for most questions, Email for more private discussions like grading, issues, etc.)
Email:	minniche@usc.edu
Office Hours:	Wednesdays 5:00-6:00 PT, "virtual" via BlueJeans (details to follow, subject to change based on student availability)
Teaching Assistant:	TBD
Phone (mobile):	TBD
Office Hours:	TBD
Email:	TBD

References:

Required:

1. 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.
    a. The electronic version is included with paid regular or student membership in INCOSE or, for USC students, with a free CAB-limited membership. Many corporations and government organizations are also CAB members. https://www.incose.org/about/Membership/Join
    b. If you are buying a hard copy, please make sure it's the 4th Edition.
2. Department of Defense Acquisition University, *Systems Engineering Fundamentals,* 2001. Free government PDF document online: http://spacese.spacegrant.org/SEModules/Reference%20Docs/DAU_SE_Fundamentals.pdf
3. *NASA Systems Engineering Handbook,* NASA/SP-2016-6105 Rev2, 2017. Free government PDF, Kindle, or eBook document online: nasa.gov/sites/default/files/atoms/files/nasa_systems_engineering_handbook_0.pdf

Recommended:

4. *Systems Engineering and Analysis,* 5th Edition, Blanchard and Fabrycky, Prentice Hall, 2011.
5. *Defense Acquisition Guidebook,* Defense Acquisition University, Chapter 3, "Systems Engineering", 11/2017 (or later update).

dau.mil/tools/dag - Click on Chapter 3

6. Expanded Guidance for NASA Systems Engineering (Volumes 1 and 2), NASA/SP-2016-6105-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

Other references will be uploaded to DEN, a few to be assigned as required readings throughout the course.

Other Resources:

USC Distance Education Network (DEN): http://gapp.usc.edu/den

USC DEN Desire2Learn: https://www.uscden.net/

DEN Exams and Proctoring,	denexam@usc.edu, (213) 821-3136 Fax: (213) 821-0851
Instructional Support Center,	dennotes@usc.edu. (213) 740-9356
Technical Support, Online Services, Webcast Problems, Software Questions or General Technical Questions	webclass@usc.edu (213) 821-1321

Course Description:

Systems engineering is the engineering discipline dedicated to the integrated system design from a holistic perspective. It involves viewing the system problem space in its entirety from the initial concept throughout the lifecycle to retirement. As systems and system of systems grow in complexity, the importance of an interdisciplinary approach that takes in consideration stakeholder's needs, design, cost, production, safety, quality, test, implementation and the impact of the system's use in the environment, becomes increasingly important.

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 meets 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, management of complex systems

requirements, examining alternative solutions, utilizing concurrent engineering design, and considering a variety of realistic constraints, such as economic (business case) factors, safety, reliability, aesthetics, environmental, ethics, social impact, production, and operations.

Among the topics to be covered in the class are:

- Perspectives of Systems, System Types and System Architecture
- Systems Engineering Process, Acquisition, & Life Cycle Models
- The Value of Systems Engineering
- Systems Engineering Standards
- Systems Thinking and the Systems Approach
- Requirements & Functional Analysis
- Synthesis, Architecting, and Design
- Systems Analysis and Control
- Specialty Engineering
- Implementation, Integration, Transition, Operation, Sustainment, and Disposal
- Integration, Verification, Validation, and Test
- Model Based System Engineering
- Real World Considerations & Advanced Topics

Course Objectives:

Scope

Systems engineering is a multi-disciplined approach to transform operational needs and requirements into an integrated system design solution through the concurrent considerations of the entire enterprise and life cycle of the system under consideration. This course will acquaint you with concept of systems and the role systems engineering plays in their development. It will also provide a basic framework for problem solving and integrated enterprise thinking within the systems engineering process.

It is the intent of this course to give the student a strong foundation in the fundamentals of system engineering, and at the same time, introduce the student to innovative systems approach to problem solving and team leadership.

Goals

1. Establish an understanding of basic system and systems engineering concepts and terms
2. Introduce systems engineering as a problem-solving process / approach, project decision support, and its relationship to program life cycle
3. Instill in the minds of the students that systems engineering is holistic thinking
4. Understand the systems engineering technical processes and their interactions
    a. Understand how the technical processes are both distinct and integrated
    b. Produce various systems engineering artifacts
    c. Reflect the systems engineering principles in the development of artifacts
    d. Understand useful theories, models, techniques and tools
    e. Address design for operational feasibility (specialty engineering) concepts

5. Enable the students to develop their systems thinking and leadership skills by developing a class project
6. Improve the student's "team and soft skills"

Course Highlights:

1. Lectures
2. Homework assignments (individual and team-based)
3. Team projects
4. Midterm exam / Final exam

These activities 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.

Course Grading:

USC Grading Policies shall be followed. The course activity breakdown is as follows:

Homework Assignments	20%
Midterm and Final exam	40%
Team Project	40%

All assignments will be submitted through DEN Desire2Learn 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, homework is due at 10:00 am PT on the day of the lecture following the week that it is assigned. Please consult the teaching assistant or instructor before the day the homework is due if there are special circumstances that prevent you from submitting homework 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 conversations among students are not allowed. These practices are distracting to the on-going lecture. These courtesies also extend to DEN students who should mute their phones during lecture when not speaking to the class.

Plagiarism:

University policies on plagiarism are in effect. For the final project paper, material may not be directly extracted from web sites or other sources, including internal company documents unless properly cited. Quotations within quotation marks are expected and references cited. Papers will be submitted to turnitin.com.

Planned Course Schedule (subject to change):

Mtg #	Topic	Reading and Homework Assigned
Week 1 Jan 11	Course Overview // Introduction to Systems Engineering Concepts // Value of Systems Engineering	INCOSE SEH, Ch. 1&2 DoD SE Fundamentals, Ch. 1&2 NASA SEH, Ch. 1&2 HW #1 (incl. "book report" topic)
Week 2 Jan 18	Systems Engineering Processes Overview & Life Cycles // "Book Report" selection due	INCOSE SEH, Ch. 3 DoD SE Fundamentals, Ch. 3 NASA SEH, Ch. 3 HW #2 (incl. one artifact from team mtg)
Week 3 Jan 25	Mission & Business Analysis // Stakeholders, Needs, Scope, and CONOPS // Proposed project topic due	INCOSE SEH, Ch. 4.1-4.2 DoD SE Fundamentals, Ch. 4.1 NASA SEH, Ch. 4.1 HW #3
Week 4 Feb 1	Requirements Analysis and Development // Prioritized team topics due early	INCOSE SEH, Ch. 4.3 DoD SE Fundamentals, Ch. 4 NASA SEH, Ch. 4.2, 6.2, App. C HW #4
Week 5 Feb 8	Functional Analysis and Allocation	INCOSE SEH, Ch. 9.3 DoD SE Fundamentals, Ch. 5 NASA SEH, Ch. 4.3 NASA ExpGuidance v2 App. F HW #5 (incl. "book report")
Week 6 Feb 15	Architecture Definition // Design Definition // "Book Report" due	INCOSE SEH, Ch. 4.4-4.5 DoD SE Fundamentals, Ch. 6 NASA SEH, Ch. 4.4 NASA ExpGuidance v2 7.2-7.3 HW #6
Week 7 Feb 22	Systems Analysis and Control	INCOSE SEH, Ch. 4.6, Ch. 5.2-5.7, 9.1 DoD SE Fundamentals, Ch. 10, 12-15 NASA SEH, Ch. 6.3-6.7, App. L HW #7
Week 8 Mar 1	Team presentations // Action Item Prep // Review for Midterm	HW #8 – incl. draft AIs and feedback
Week 9 Mar 8	Midterm Exam – NO LECTURE (Open Book, online)	HW #9

Mtg #	Topic	Reading and Homework Assigned
(Mar 15)	(SPRING BREAK – NO LECTURE)	
Week 10 Mar 22	Implementation, Integration, & Transition, Interface Analysis	INCOSE SEH, Ch. 4.7, 4.8, 4.10, 5.8, 9.6-9.7 NASA SEH, Ch. 5.1-5.2, 5.5, App H Aerospace Mission Assurance Guide 1.1-1.5, 1.8, 6.5 HW #10
Week 11 Mar 29	Verification, Validation, Quality, Test // Mission Assurance – Guest (half) Lecturer: J. Wyrwitzke AI's due	INCOSE SEH, Ch. 4.9, 4.11 DoD SE Fundamentals, Ch. 7 NASA SEH, Ch. 5.3-5.4, App. D, E, I HW #11
Week 12 Apr 5	Specialty Engineering, Security //	INCOSE SEH, Ch. 10 HW #12
Week 13 Apr 12	Decision Analysis and Value Functions // Cost Analysis – Guest (half) Lecturer: R. Lewis AI Dispositions Due	INCOSE SEH, Ch. 5.3, 10.1 NASA SEH, Ch. 6.8 NASA ExpGuidance v1 6.1.2.2 HW #13
Week 14 Apr 19	Model-Based Systems Eng. Guest (whole) Lecturer: M. Sievers (SAE547)	INCOSE SEH, Ch. 9.1 (review), 9.2 HW #14
Week 15 Apr 26	Operation, Maintenance, Disposal // Review & Final Exam focus areas	INCOSE SEH, Ch. 4.12-4.14
FINAL: **TUESDAY** May 8	Final Exam: (closed book, proctored, very focused)	**Tuesday May 8, 2:00 PT** (university exam schedule) Location: **TBD**

Weekly Homework (20% of course grade):

- Will be assigned weekly to work the following week.
- Will be due the next Thursday at 10:00 a.m. PT
- Late homework received before class at 3:30 p.m. PT will be accepted and graded with a 10% penalty. [Rationale: Motivate an early input to provide a brief opportunity to review submissions prior to lecture and comment, but with small penalty.]
- Late homework received after the class starts (where the answers may be discussed) will be accepted for one more week and graded with a 50% penalty. [Rationale: Once we discuss the answers, it's obviously easier to provide the responses, but there is still learning value in terms of working it out and writing it down.]

Book Report: (Optional, Extra Credit)

If you choose to participate, then select one book from the list below that you haven't read before signing up for this class:

- Donella Meadows, "Thinking in Systems: A Primer", 2008. 240 pages.
- Hammond and Keeney, "Smart Choices: A Practical Guide to Making Better Decisions", 2015. 256 pages.
- Janine Benyus, "Biomimicry: Innovation Inspired by Nature", 1997/2002. 308 pages. (introductory 20-minute video: treemedia.com/biomimicry)
- de Weck, Roos, and Magee, "Engineering Systems: Meeting Human Needs in a Complex Technological World", 2011. 183 pages.
- Peter Bernstein, "Against the Gods: The Remarkable Story of Risk", 1998. 400 pages.

None of these teach systems engineering processes the way we study them in this class. They are all somewhat peripheral, but definitely related, to the core topics in this class. And they are all relatively easy reading (although they all take work to put into practice).

Identify your selected book at Week 2 as part of homework #1. Submit your "book report" (about 2 pages) in Week 6 along with homework #5. Your report should address the question: How do the concepts in this book relate to the stakeholder needs and requirements development process? It should also refer to and integrate into the theme at least 3 concepts or quotes from different parts of the book.

This should be an enjoyable assignment that lets you explore a peripheral topic of interest while integrating it into your "systems thinking" approach. If you don't think it will be enjoyable, you shouldn't do it – it's optional with a relatively small grade impact.

Team Project initial products (20% of course grade):

During weeks 2 – 8, we'll divide into teams of 4-6 students (or "groups" in Desire2Learn) to conduct team projects. Each team will develop a specification for a new capability of some sort that goes beyond currently available capabilities and present that spec in a 15-minute presentation in the style of an abbreviated requirements review.

The various teams will work on different versions of a similar project, to be defined at the first lecture.

During week 8 class, the team makes a 15-minute presentation of their results to the class. Team submits one "specification" and one presentation prior to the week 8 class, and may update these the following day (any significant but simple feedback from the presentation can be incorporated in this next-day update). Format of submissions will be discussed in class in advance.

As part of HW#8 (due week 9), each student rates each teammate:

- Exceeded expectations and sort of "carried the team"; maybe "dominated"
- "Pulled his or her weight"; contributed substantially and consistently to ideas and discussions – I hope most people will be in this category

- Participated somewhat, minor contributions, but not really significant; this is also how you should rate someone if you really don't know if they contributed or not
- Completely slacked off; just didn't contribute at all, maybe didn't even show up

Grading: The grade of everyone on the team will be dominated by the graded quality of the products and presentation. There may be small individual adjustments up and down due to teammate ratings on individual participation. I will not indicate if any adjustments were made in the grade provided to the student. Please don't discuss with any teammate before the fact how you will rate another teammate. Please don't discuss your grade on your project with your teammates after the fact – their grade may be different.

Individual Feedback to Projects – Assessment and "Action Items" (10% of course grade):

Individuals will provide "action item" feedback or clarification requests to the other teams' projects in a formal design review "action item" format. We will discuss the use and intent of this process in class.

Update to Projects incorporating provided feedback (10% of course grade):

Teams will disposition the action items that they receive, determining if each needs to be addressed, and if so, if it is a future action for the team (beyond the scope of this review and this class project) or should result in an update to the design review products (specification and presentation). Updates will be incorporated and submitted as a "final" set of products.

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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