

## SYLLABUS

SAE 549: Systems Architecting

Spring 2023

**Class Session:** Monday, 3:30 pm – 6:10 pm, ONLINE

**Class Section:** 32319D (DEN/Off-campus) and 32349D (On Campus OHE120)

### **Contact Information:**

Instructor: Dr. Robert Joseph Minnichelli  
Office hours: Virtual, By Appointment Only  
E-mail: [minniche@usc.edu](mailto:minniche@usc.edu)

Special Guest Lectures by Prof. Ellen  
Pawlikowski

Teaching Assistant: Shatad Purohit  
Office hours: Virtual, By Appointment Only  
Office location: OHE 500  
Office phone: 213-421-4860  
E-mail: [shatadkp@usc.edu](mailto:shatadkp@usc.edu)

Kindly use online discussion boards (available on D2L) if you have any questions on course materials, mid-term, or final paper. The turnaround time for TA to answer questions is 24 hours.

### **Course Learning Objectives:**

- To improve students' ability to think critically, ask the right questions, and apply the right methods when architecting various types of systems.
- To improve students' understanding of the role of system architects and their relationship to systems engineers and transdisciplinary systems engineering using TRASEE™ education paradigm
- To introduce the students to new, advanced multidisciplinary topics (e.g., systems thinking, systems modeling, psychological principles in systems architecting, biologically inspired architectures, agent-based modeling, human capabilities and limitations, human behavior modeling) relevant to complex systems architecting.
- To introduce the students to key concepts associated with trade-off analysis which are important to both systems architecting and engineering.

### **Readings and Notes:**

- Weekly lecture notes will be posted on the Desire to Learn (<http://www.courses.uscdcn.net>)
- Required Text:
  - Maier, M., & Rechtin, E. (2009). *The art of systems architecting* (3rd ed.). Boca Raton, FL: CRC Press ISBN: 978-1-4200-7913-5 *Note: you can download this book through USC Libraries for free.*
  - Bahill, T. A., Madni, A.M., “*Trade-off Decisions in Systems Design*” Springer, 2017. *Note: you can download this book through USC Libraries for free.*
  - Madni, A.M. *Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-connected World*, Springer, 2018 *Note: you can download this book through USC Libraries for free.*

### **Grade**

Your grade will be based on one exam (will account for 40% of your final grade) *and* a final term paper (*which will account for the remaining 60% of your final grade*). The exam will be administered online through Desire 2 learn.

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### Exam

- The exam will consist of multiple questions that will test students' knowledge about the fundamentals of systems architecting, complex systems, and systems thinking. The exam will be on all the subjects covered in previous lectures and assigned readings. This will be a timed exam (2 hours and 40 minutes). The exam will be administered on **Monday April 03, 2023**.
- **Collaboration on the exam is forbidden.** Violators will receive an automatic F for the course.

### Term Paper:

The term paper should address the following problem:

*Describe and analyze the architecture of a selected system as a case study. Your analysis should discuss how the architecting process led to the architecture. The architecting process should address the heuristics used, key tradeoffs, questions posed, people involved, options generated, and decisions made, the outcomes and implications for the future.*

**Submit a maximum 1-page draft abstract by Feb 06, 2023, 3:30 PM on your chosen topic.**

Student must write on a specific system from one of the following categories.

- Autonomous Systems
- Smart phones or smart tablet computers
- Passenger Aircraft
- Space Telescopes
- Robotic Systems
- Manned Space Transport
- Airborne Platforms (Fighter /Bomber aircraft/helicopter/Unmanned Aerial Vehicles)

**LENGTH:** The term paper should be between 6-8 pages (excluding references and appendices, and cover page), single-spaced, in 12-point type. The term paper is due on or before **May 3, 2023, 3:30 PM**.

**DELIVERY:** The term paper must be submitted through the Desire to Learn (D2L) system. Links for submitting final paper will be available on D2L (<http://courses.uscdcn.net>).

**LATENESS:** Term papers are due on **May 3, 2023, 3:30 PM**. *No late papers will be accepted after the due date and time, and the student will receive an automatic F grade for final paper.*

### UNIVERSITY LEVEL ISSUES

#### ■ **Statement for 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 GFS 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is

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(213) 740-0776.

■ **Statement on Academic Integrity:**

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 13.00, while the recommended sanctions are located in Appendix A:

<https://scampus.usc.edu/university-student-conduct-code/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

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**Schedule of Class Sessions:** The exact schedule is likely to change, based on availability of guest lecturers. Dates of readings may change to align with other schedule adjustments. Changes will be announced.

2023	Lecture Topics	Readings
Jan 09	SAE Program, Course Overview, and Intro to Systems Architecting	<i>Submit student bio by Sunday Jan 15, 11:59 PM</i> -Preface, Introduction, Chapter 1 and Case Study 1: DC-3 from Maier and Rehtin 2009 -Chapter 1 from Madni 2018
Jan 16	University Holiday – No Class	
Jan 23	Architecture Tradeoff Analysis and Ontology Enabled Systems Architecting	-Madni, A.M., and Ross, A. “Exploring Concept Trade-offs,” Chapter 10 in “Trade-off Analytics,” Eds Parnell G., Wiley 2016 -Chapter 5 of Bahill and Madni 2017
Jan 30	Role of Heuristics in Systems Architecting	-Chapter 2 and Appendix A from Maier and Rehtin 2009 -Section 2.4 from Bahill and Madni 2017 -Section 8.6 from Madni 2018
Feb 06	Human-System Integration: Implications for Systems Architecting	<i>Submit abstract by 3:30 PM Monday Feb 06, 2022</i> - Chapter 7 from Madni 2018 - A. M. Madni, M. Sievers, and C. C. Madni, “Adaptive Cyber-Physical-Human Systems: Exploiting Cognitive Modeling and Machine Learning in the Control Loop,” Insight (International Council on Systems Engineering), vol. 21, no. 3, pp. 87–93, 2018, doi: 10.1002/inst.12216.
Feb 13	Digital Twin Technology: A Key Enabler of Systems Architecting and Engineering	A.M. Madni, C.C. Madni; Lucero, S.D. Leveraging Digital Twin Technology in Model-Based Systems Engineering. Systems 2019, 7, 7. <a href="https://doi.org/10.3390/systems7010007">https://doi.org/10.3390/systems7010007</a>
Feb 20	University Holiday – No Class	
Feb 27	Cyber Physical-Human Systems and Testbed	- A. M. Madni and S. Purohit, "Augmenting MBSE with Digital Twin Technology: Implementation, Analysis, Preliminary Results, and Findings," 2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC), 2021, pp. 2340-2346, doi: 10.1109/SMC52423.2021.9658769.
March 06	Guest Lecture – Ontology-Enabled Hardware-Software Testbed for Engineering Adaptive Systems	<i>Submit outline of paper by 3:30 PM Monday March 06, 2022</i> -E. Ordoukhanian., A.M. Madni; (2022). Ontology-Enabled Hardware-Software Testbed for Engineering Adaptive Systems. In: Madni, A.M., Boehm, B., Erwin, D., Moghaddam, M., Sievers, M., Wheaton, M. (eds) Recent Trends and Advances in Model Based Systems Engineering. Springer, Cham. <a href="https://doi.org/10.1007/978-3-030-82083-1_16">https://doi.org/10.1007/978-3-030-82083-1_16</a>
March 13	University Holiday – No Class	
March 20	Guest Lecture: Case Study – GPS Part 1	Chapter 3, Chapter 7, and Case Study 5: The Global Positioning System, and Chapter 13 from Maier and Rehtin 2009
March 27	Model-Based Systems Architecture using Dependency Structure Matrix	-Part III Introduction, Chapter 8 from Maier and Rehtin 2009 - A. M. Madni and M. Sievers, “Model-based systems engineering: Motivation, current status, and research opportunities,” Systems engineering, vol. 21, no. 3, pp. 172–190, 2018, doi: 10.1002/sys.21438.

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		- S. Purohit and A. M. Madni, "A Model-Based Systems Architecting and Integration Approach Using Interlevel and Intralevel Dependency Matrix," IEEE systems journal, vol. 16, no. 1, pp. 747–754, 2022, doi: 10.1109/JSYST.2021.3077351.
April 3	<b>Midterm</b>	
April 10	Guest Lecture: Case Study – GPS Part 1	Chapter 5, Chapter 6, Chapter 12, and Case Study 3: Intelligent Transportation Systems from Maier and Rechtin 2009
April 17	Transdisciplinary Systems Engineering	A. M. Madni, "Transdisciplinary Systems Engineering: Exploiting Disciplinary Convergence to Address Grand Challenges," in IEEE Systems, Man, and Cybernetics Magazine, vol. 5, no. 2, pp. 6-11, April 2019, doi: 10.1109/MSMC.2019.2899957.
April 24	Course Review	
<b>May 03</b>	<b>Final Papers Due at 3:30 PM</b>	