

## SYLLABUS

**SAE 549: Systems Architecting**

**Fall 2022**

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

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

### **Contact Information:**

Instructor: Prof. Azad M. Madni

Office hours: Virtual, By Appointment Only

Office location: OHE 500

Office phone:

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: RAN 215

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. The use of email should be limited to emergency situations. The TA will consult with instructor before responding.

### **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

## SYLLABUS

SAE 549: Systems Architecting

Fall 2022

through Desire 2 learn.

### 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 October 17, 2022**.
- **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 October 03, 2022, 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 **December 9, 2022, 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 **December 9, 2022, 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

## SYLLABUS

SAE 549: Systems Architecting

Fall 2022

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 (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/>.

## SYLLABUS

**SAE 549: Systems Architecting**

**Fall 2022**

**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.

2022	Lecture Topics	Readings
Aug 22	SAE Program, Course Overview, and Intro to Systems Architecting 1	-Preface, Introduction and Chapter 1 from Maier and Rechtin 2009 -Chapter 1 from Madni 2018
Aug 29	SAE Program, Course Overview, and Intro to Systems Architecting 2	<i>Submit student bio by Sunday August 28, 11:59 PM</i> Case Study 1: DC-3, Chapter 3, Case Study 3: Intelligent Transportation Systems, and Chapter 7 from Maier and Rechtin 2009
Sept 05	University Holiday – No Class	
Sept 12	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
Sept 19	Role of Heuristics in Systems Architecting	-Chapter 2 and Appendix A from Maier and Rechtin 2009 -Section 2.4 from Bahill and Madni 2017 -Section 8.6 from Madni 2018
Sept 26	Guest Lecture: Case Study – Global Information Grid	Chapter 5, Chapter 6, and Chapter 12 from Maier and Rechtin 2009
Oct 03	Model-Based Systems Architecture using Dependency Structure Matrix	<i>Submit abstract by 3:30 PM Monday October 03, 2022</i> -Part III Introduction, Chapter 8 from Maier and Rechtin 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. - 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.
Oct 10	Human-System Integration: Implications for Systems Architecting	- 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.
Oct 17	<b>Midterm</b>	
Oct 24	Architectural Frameworks	Chapter 9, Chapter 10 and Chapter 11 from Maier and Rechtin 2009
Oct 31	Guest Lecture – Model Based Systems Engineering and Design Reuse	
Nov 07	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.

## SYLLABUS

SAE 549: Systems Architecting

Fall 2022

Nov 14	Guest Lecture: Case Study - Ballistic Missile Defense System	Case Study 5: The Global Positioning System, and Chapter 13 from Maier and Rechtin 2009
Nov 21	Application of Ontologies in Systems Architecting	- A. M. Madni, W. Lin, and C. C. Madni, "IDEONTM: An extensible ontology for designing, integrating, and managing collaborative distributed enterprises," Systems engineering, vol. 4, no. 1, pp. 35–48, 2001, doi: 10.1002/1520-6858(2001)4:1<35::AID-SYS4>3.0.CO;2-F. -A.M. Madni, Minimum Viable Model to Demonstrate Value Proposition of Ontologies for Model-Based Systems Engineering. In: Madni, A.M., Boehm, B., Erwin, D., Moghaddam, M., Sievers, M., Wheaton, M. (eds) Recent Trends and Advances in Model Based Systems Engineering 2022. Springer, Cham. <a href="https://doi.org/10.1007">https://doi.org/10.1007</a>
Nov 28	Course Review	
<b>December 09</b>	<b>Final Papers Due at 3:30 PM</b>	