SYSTEMS ARCHITECTING AND ENGINEERING PROGRAM

SAE 599: Engineered Resilient Systems & System-of-Systems

Spring 2016

Class Day and Time: Monday, 6:40-9:20 PM
Location: OHE 120

Instructor: Professor Azad M. Madni
Office: RRB 201
Office Hours: By Appointment Only
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Teaching Assistant: None
Office: TBD
Office Hours: TBD
Contact Info: TBD
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COURSE DESCRIPTION
Resilience Engineering has become an important subject in systems engineering, as systems continue to grow in size, scale, and complexity. This course provides Systems Architects and Engineers with key definitions, concepts and methods for the design and analysis of resilient systems and system-of-systems (SoS).

LEARNING OBJECTIVES
- Introduce students to the different definitions of resilience in various domains
- Introduce students to key resilience concepts associated with systems and system-of-systems (SoS)
- Introduce students to complexities posed by adaptable systems and impact on human-systems integration
- Introduce students to key approaches for engineering resilient systems and system-of-systems
- Improve students' ability to write a scholarly research paper suitable for peer-reviewed conferences

Prerequisite(s): None; however, SAE 549 *Systems Architecting* is recommended
Recommended Preparation: 2 years of Systems Engineering desirable, but not necessary

FINAL GRADE
Your grade will be based on a Mid-term Exam, and a Final Term Paper. Midterm will account for 40% and the Final Term Paper will account for the remaining 60% of the final grade. There will be extra credit assignments during the semester.

MIDTERM EXAM
The mid-term will consist of multiple questions that require short answers. It will test the students'

knowledge about the fundamentals of resilience engineering. This will be a take home, open book exam on topics covered in lectures up to that point. It will be assigned on **March 7 at 9:30 PM** and it will be due **March 8 at 11:59PM**.

FINAL TERM PAPER
TOPIC**:** Select a complex system or system-of-systems from following domains: 1) Aerospace/Space; 2) Energy; 3) Healthcare and discuss how you would introduce resilience into the selected system or system-of-system. You research paper should build on the resilience concepts presented in the class and the reference papers.

The paper quality should be commensurate with the quality expected in peer-reviewed conference publications. Target conferences include CSER, INCOSE IS, IEEE SMC International Conference, IEEE Systems Conference, AIAA Infotech@Aerospace, and AIAA Science and Technology Conference.

The student is expected to propose a topic, and get it approved by the instructor and/or TA:
- It can be something that the student has been personally involved in, or something that is of interest to the student.
- It should address a system where the need for resilience is well- recognized, and the measures of effectiveness are available

APPROVAL: You must submit a one-page abstract regarding your proposed topic for approval. Please submit on-line via D2L Assignments no later than **February 16 2016 by 6:30PM**.

FORMAT: Microsoft WORD (.DOC) or Adobe Acrobat (.PDF) format for abstracts and research papers. A list of sources and contacts is essential, listing what sources you used and anyone you interviewed. Be sure to provide the URLs of any Internet sources used in your research.

LENGTH: The term paper should be between **10-12 pages, single-spaced, single column in 12-point type**. This includes all references, figures and tables.

DELIVERY: Please submit on-line via Desire to Learn Assignments no later than **April 25 2016 by 6:30 PM.**

SOURCES: You must properly reference all sources. We will use the turnitin.com service to look for matches with existing books, magazine and newspaper articles, journals, prior student papers, and all Internet sources. If you directly quote text from a source, you must properly designate quoted material "in quotation marks" or in italics, and give a citation for each quotation via a footnote or a numbered reference or in-text (author-date) notation. The amount of quoted text relative to the total text in your paper should be kept to a minimum—if excessive; this will detract from your paper's grade.

WARNING: Failure to properly designate copy-and-pasted text will be considered as a violation of academic integrity (see University Policy Statements at the end of this syllabus). This includes quotations from your prior papers (e.g. from SAE 549 or other classes)! You can build on your own work from other classes, and from other author's works, as long as you properly cite those

references. You must not directly copy text from those sources (unless properly marked and cited as a quotation). Instead, you must add value by citing then restating such work in your own words plus your own enhancements, such that the combination has enhanced relevance to this class. You can directly copy graphics, tables, or figures if you give a citation for each copied item. Although there is no limitation on the relative amount of copied items, your own artwork—however crude yet clearly legible and illustrative—is always acceptable.

LATENESS: Term papers are due on **April 25 2016 by 6:30 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.**

LIMITS: I cannot accept a request to limit access to your abstract or research papers. Although I do not plan to disseminate your work without your permission, I cannot guarantee that other people (including non-US citizens) will not view or handle your submitted materials. Thus you must not use classified, proprietary or company limited-distribution materials in your coursework. If your employer requires review and approval for your submitted materials (e.g. Public Affairs Office or Export Compliance Review) then you must obtain such approval within the deadlines listed in this syllabus. As the approval practices in many companies may be time consuming, the best practice is not to use company material at all.

Additional Information:
- Please feel free to discuss the structuring of your research plan at the end of the class.
- If English grammar, spelling and syntax are not your strong points, I strongly suggest that you obtain help in editing your text. Your grade depends on the clarity of writing.

Course Schedule: A Weekly Breakdown

2016	Topics	Assigned Readings
Jan 11	Introduction to SAE Program, and Class, Definitions of Resilience in different domain	Goerger, Simon R., Azad M. Madni, and Owen J. Eslinger. "Engineered resilient systems: a dod perspective." *Procedia Computer Science* 28 (2014): 865-872.
Jan 18	University Holiday	
Jan 25	Key Resilience Concepts and Limitations of Current Approaches for systems and SoS	Madni, A. M. "Adaptable platform-based engineering: Key enablers and outlook for the future." *Systems Engineering* 15.1 (2012): 95-107. Madni, A.M., and Scott Jackson. "Towards a conceptual framework for resilience engineering." *Systems Journal, IEEE* 3.2 (2009): 181-191.
Feb 1	Guest Lecture	
Feb 8	Factors influencing System/SoS Resilience (e.g., autonomy, legacy, flexibility, interoperability)	Neches, Robert, and Azad M. Madni. "Towards affordably adaptable and effective systems." *Systems Engineering* 16.2 (2013): 224-234.
Feb 15	University Holiday	
Feb 22	Systems Thinking in Designing Resilience Mechanisms	Madni, A.M. "Generating Novel Options during Systems Architecting: Psychological Principles, Systems Thinking, and Computer-Based Aiding." *Systems Engineering* 17.1 (2014): 1-9.
Feb 29	System Architecture: Key Perspectives and Concepts	Madni, A.M. "Generating Novel Options During Systems Architecting: Psychological Principles, Systems Thinking, and Computer-Based Aiding," pages 1-9, Systems Engineering, Volume 16, Number 4 2013.(Google Scholar)
Mar 7	*Midterm*	*No class. Assign at 6:40 PM. Due March 8 by 11:59 PM*
Mar 14	Spring Break.	
Mar 21	Guest Lecture	
Mar 28	Tradespace Analysis in Engineered Resilient Systems and SoS	Madni, A.M. "Systems Engineering Tradeoffs Analysis: Challenges and Promising Themes," IIE Annual Conference and Expo, ISERC 2015, May 30- June 2, 2015
Apr 4	Guest Lecture	
Apr 11	Guest Lecture	
Apr 18	Human-System Integration and Adaptive Systems	Madni, A.M. "Integrating Humans With and Within Complex Systems: Challenges and Opportunities," (Invited Paper) CrossTalk, The Journal of Defense Software

		Engineering, May/June 2011, "People Solutions." (Google Scholar)
		Madni, A. M. 2010. Integrating Humans With Systems and Software: Technical Challenges and Research Agenda. Systems Engineering, 13(3): 21.
Apr 25	Course Review	

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 STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

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, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

EMERGENCY PREPAREDNESS/COURSE CONTINUITY IN A CRISIS

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.