This syllabus is compliant with GMU Catalog Policy AP.2.5.

Course Title: Intro. To System-of-Systems and Mission Engineering
Course Number: SYST 633
Number of Credits: 3
Required Pre-reqs: Graduate Standing, Basic probability/statistics; Basic knowledge of Linear Algebra
Required Co-reqs: As per catalog
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Course Description:

This course introduces fundamental concepts in System-of-Systems (SoS) Engineering and their application in Mission Engineering. SoS arise when multiple independent, heterogeneous, and distributed systems are integrated to accomplish a mission. Mission Engineering is an emerging filed of study that investigates flexible orchestration of SoS to accomplish one or more missions. This course will introduce novel characteristics, architecture principles, engineering management, and analysis of SoS along with introduction to foundational concepts of Mission Engineering.

Class Details

Lecture Time:
TBD

Lecture Location:
TBD

Office hours:
TBD
Or by appointment
Office Location: ENGR 2202

Dr. Raz Contact Details:
Office Phone: 703-993-4715 (not a good option to reach me)
Email: araz@gmu.edu (always include Syst 633 in subject line)

Course Modality:

In Fall 2026, SYST 633 is scheduled to be an in-person course. All students are expected to attend the class at the scheduled time.

Course Learning Outcomes:

SYST 633 is the graduate-level core course in Systems Engineering with a focus on System of Systems and Mission Engineering. System-of-Systems are becoming increasingly important in modern society where systems rarely exists in isolation. Independently developed, managed, and operated systems depend on one another to accomplish missions ranging from transportation networks, supply chains, and internet-of-things, to distributed command-and-control systems. It has been well recognized in literature that traditional SE approaches fail to address the unique challenges that arise in SoS architecture design and evaluation. Mission Engineering is taking a step further in SoS and seeks to develop flexible approaches for SoS architecture and evaluation. This course will introduce the state-of-the-art in SoS Engineering and emerging concepts in Mission Engineering.

At the completion of the course, the students will be able to:

- Distinguish characteristics of System-of-Systems (SoS) from otherwise Complex Engineered Systems
- Compare traditional systems engineering with SoS Engineering
- Describe and tailor Systems Engineering Processes for application to SoS
- Compare and contrast SoS management to system management
- Employ mathematical constructs to perform SoS analysis and identify interdependencies
- Define Mission Engineering in context of SoS
- Perform mission-oriented SoS analysis and design
- Identify approaches for developing, modeling, and simulating a SoS architectures and missions

Course Schedule

Detail course schedule is available on Canvas which includes reading assignments, due dates of all assignments, and project deliverables. Following are some important dates to plan your semester.

Important Dates:

Last Day to Add: TBD
Last Day to Drop (without financial penalty): TBD
Last Day to Drop (with financial penalty): TBD
Unrestricted Withdrawal (100% tuition penalty): TBD
(withdrawing from this class after this date requires the approval of the dean and is only allowed for nonacademic reasons.)

More information on the Fall semester calendar at:
https://registrar.gmu.edu/calendars/spring_2026/

Weekly Course Plan (Up to date copy on Canvas):

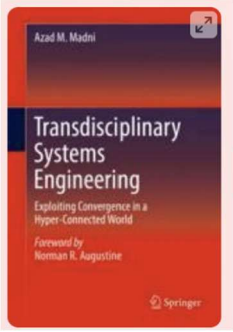
Week 1: Introduction of SoS Engineering and Mission Engineering; Course Logistics
Week 2: SoS Fundamentals and SoS Engineering Approaches
Week 3: SoS Process Models and Tailoring of Systems Engineering Processes
Week 4: SoS Architecture Principles and Frameworks
Week 5: SoS Architecture with Unified Architecture Frameworks
Week 6: SoS Analysis with Graph Theory
Week 7: SoS Modeling and Simulation
Week 8: SoS Emergence and Complexity Analysis
Week 9: Mission Engineering Formulations with SoS
Week 10: Mission Engineering Ontologies and their role for SoS Architectures
Week 11: Creating Mission Threads with Temporal Logic
Week 12: Analysis and Evaluation of Mission Threads
Week 13: SoS with Autonomous Systems
Week 14: Advanced concepts in SoS and Mission Engineering

Exercise planning, be proactive, and do your best to stay ahead of schedule.

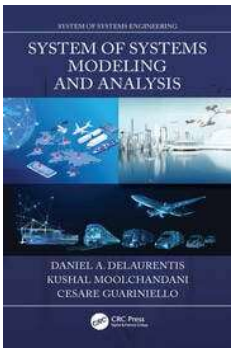
Textbook (Recommended):

We will use the following books as assigned textbooks for this course. In addition, class notes constitute a major portion of learning materials for this course.

Textbook:

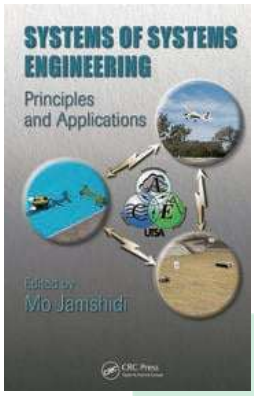


Madni, Azad, Transdisciplinary Systems Engineering, Exploiting Convergence in a Hyper-Connected World, Springer Nature, 2018

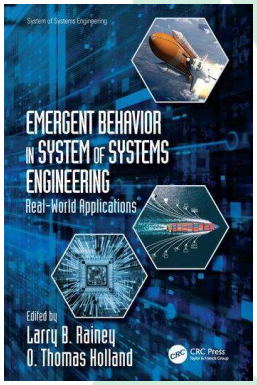


DeLaurentis, Daniel A., Kushal Moolchandani, and Cesare Guariniello. *System of systems modeling and analysis*. CRC Press, 2022.

Reference book:



Jamshidi, Mo, ed. *Systems of systems engineering: principles and applications*. CRC press, 2017.



Rainey, Larry B., and O. Thomas Holland, eds. *Emergent Behavior in System of Systems Engineering: Real-World Applications*. CRC Press, 2022.

Course Deliverables and Evaluation:

The grading structure of this course is as follows:

- In-Class Participation (10%)
- Homework (30%)
- Mid-Term (20%)

- Literature Review Presentation (10%)
- Today I Learnt (5%)
- Group Project (25%)
- Bonus Points (up to 3%)

All course deliverables must be submitted via CANVAS. I will **not accept** electronic copies via email.

Course Grading:

Your final course grade will be assigned based on the following table:

Letter Grade	Cumulative Score (%)	Letter Grade	Cumulative Score (%)
A+	97+	B+	87+
A	93	B	83
A-	90	B-	80

Similar breakdown applies to other letter grades below B-

Course Software:

In addition to MS Office 365, we will use Cameo Magic System of Systems which is a software for Model-based Systems Engineering and Systems Modeling Language. Download instructions and student license for the software is provided on Canvas.

Course Logistics and Expected Behavior:

1. All course materials will be provided via the Canvas system. Students are expected to have access and be able to use the system before classes start. Canvas is accessible at https://info.canvas.gmu.edu/ .
2. Volgenau School Computing Resources has answers to many questions about school systems on their web site: http://labs.vse.gmu.edu and will try to help you if have problems connecting to school computing systems. However, they will not provide assistance with general computing questions or course assignments. Please contact me if you have any questions about how to use software to complete your assignments. Please refer to the following link on http://labs.vse.gmu.edu/uploads/FacultyFAQ/StudentWelcome.pdf
3. Attendance and participation in lectures is essential.
4. For Distance Learning participation, please keep your mic muted unless you need to speak. Please *turn on your cameras* at the beginning of each class, when speaking, and during open class discussions.
5. Students are permitted and encouraged to collaborate on homework assignments, but your write-up must be your own. Assignments are intended to provide practical, hands-on experience with the ideas presented in the course. If you collaborate with other students on assignments, identify their name on submission and acknowledge their contributions.

6. Religious observances are one common example of events that might impact students' activities. Students are responsible for planning ahead. Please, refer to the GMU's calendar of religious holidays at http://ulife.gmu.edu/calendar/religious-holiday-calendar/.
7. Late assignments, when properly justified, will receive reduced credit in accordance with the late assignment policy. No points will be awarded if the assignment is turned in after solutions have been posted.

Email policy:

You must use your Mason email account for all email correspondence having anything to do with your work at Mason. Federal laws protecting your privacy rights require that we only communicate student information directly to students – and use of the university email system is our only way to validate your identity. You may forward your campus email elsewhere, but we can respond only to a Mason email account.

Remember to include SYST 520 in the subject line of your email when contacting me.

Academic Integrity

Mason has an Honor Code with clear guidelines regarding academic integrity. Mason's honor code is:

> ***To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set for this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.***

The principle of academic integrity is taken very seriously, and violations are treated gravely. Refer to the full university policy and honor code at: https://oai.gmu.edu/mason-honor-code/

Note about Generative AI and ChatGPT:

ChatGPT or other Generative-AI models may be used in this course as an assistant in projects and homework assignments unless otherwise specifically stated by the instructor. Any use must follow the fundamental principles of the Honor Code and include the following statement with assignment submission: **The ideas in this submission are original and were generated by (my name). ChatGPT (or name other** Generative-AI model**) was used as an editorial/coding assistant, however, I take full responsibility for the originality and accuracy of the content. Any content generated by the Generative-AI models must be clearly identified.**

Risk accompanies use of any powerful tool. Students are cautioned that sharing their own original ideas with Generative-AI models can lead to loss of control and ownership of those ideas and coding. Furthermore, in terms of learning in this class, students who replace their own learning and project work with materials prepared by Generative-AI models:

- Surrender control over the material's truthfulness and accuracy and violate the university's Honor Code.
- Sacrifice the opportunity to acquire the knowledge, skills, and critical thinking taught in the course.
- Risk being unable to perform to expectations when Generative-AI models are unavailable, such as in exams.

- Ultimately endanger their employability if they are unable to produce work other than that produced by Generative-AI models.

For Mason provided AI-tools, students are encouraged to visit ***patriotai.gmu.edu***

Disability Accommodations

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474

Diversity and Inclusion

In this course, I seek to create a learning environment that fosters respect for people across identities. I ask all students to welcome and value individuals and their differences, including gender expression and identity, race, economic status, sex, sexuality, ethnicity, national origin, first language, religion, age, and ability.

Diversity is one of the university's core value. Refer to the following link for Mason Diversity Statement: https://stearnscenter.gmu.edu/knowledge-center/general-teaching-resources/mason-diversity-statement/

BEST WISHES FOR A GREAT SEMESTER!!!