# SYST 210: System Design

Spring 2016

## Course Description

SYST 210 introduces the systems engineering design and integration process, including the development of functional, physical, and operational architectures. The emphasis of this course is on requirements engineering, functional modeling for design, formulation and analysis of physical design alternatives. Methods and software tools for systems engineering design are introduced.
*Class time and location*: Thursdays 4:30-7:10 PM, Innovation Hall Rm 222
*Instructor:* Dr. Larrie D. Ferreiro
*Email:* lferreir@gmu.edu
*Phone: (*primary) 703-805-5423 (cell) 703-965-6419
*Office hours:* By appointment (contact instructor via e-mail to set up an appointment)
*Teaching Assistant:* TBD
*E-mail:* TBD@masonlive.gmu.edu
*Office hours and location:* TBD and by appointment (contact TA via e-mail to set up an appointment)
*Prerequisites:* 30 undergraduate hours
*Required text: The Engineering Design of Systems* (2nd Edition) by Dennis Buede ($110)
Please consider buying looseleaf version at GMU bookstore, around $70
E-book available for $53: http://store.vitalsource.com/show/9781119097365

Recommended text: *A Practical Guide to SysML*: *The Systems Modeling Language* (2nd Edition) by Friedenthal, Moore and Steiner [Note: Tutorials available online for free]

## Course Objectives

Students will learn how to:

1. Create and critique a system model, a hierarchical decomposition of the transformation of inputs into outputs.
2. Create an operational concept, external systems diagram, and objectives hierarchy for a system and use these, along with stakeholder inputs, to develop requirements for the system.
3. Define functional, physical and allocated architectures for a system.
4. Represent a system model with model-based systems engineering software tools.
5. Apply methods from decision analysis to select among options for system design, including the analysis of buy/build decisions.
6. Contribute to group problem solving.
7. Communicate a system design through oral presentation and technical documents.

## Course Requirements

Grades will be based on:

- Regular weekly homework assignments (15% of grade; lowest homework grade is dropped)
- Class and group participation (10% of grade)
- Midterm exam (15% of grade)
- Quizzes (some in-class, some handed in; 10% of grade; lowest quiz grade is dropped)
- Group (4-5 students) project and class presentation (25% of grade)
- Final exam covering material in entire course (25% of grade)

Assignments are due on ***the day of class at the beginning of class***. All assignments must be uploaded electronically through Blackboard. *If you have to turn in an assignment late, you are expected to let the instructor know **before** the due date and negotiate a date by which the assignment will be turned in. If you follow this procedure, partial credit will be given for assignments turned in by the date you have negotiated.*

*There is a great deal of work expected outside of class. Students are expected to have read the assignment prior to class. Class discussion of topics is an important part of the course. Group projects take considerable effort during the second half of the semester. Project notebooks will be turned in regularly for comments and guidance. Attendance will be taken in class. Good class attendance and strong class participation are important factors when a student's grade is on the borderline.*

## Project

Your project is an excellent opportunity to apply what you are learning to a problem in system design. Project notes are in a separate file.

Project Grading Rubric:

Group grade:

- Professionalism - Team is well dressed. Visuals are polished with uniform and appealing (but not too glitzy) style. Visuals are readable and free of grammatical errors or typographical errors. Transitions between speakers are smooth. Your team seems well practiced. (5 points)
- Coverage - You covered all the required subjects (operational concept, objectives hierarchy, external systems diagram, originating requirements, functional architecture, physical architecture, allocated architecture, interface architecture, evaluation plan). (5 points)
- Content - Your system design is well developed and appropriate for your problem. You demonstrate mastery of the content of SYST 210. (5 points)
- Clarity - Your description is clear and understandable. (5 points)
- Presentation skills (as a group) - You are poised, have good audience contact, speak directly to your listeners, with a minimum of hesitation. You

make effective use of gestures. You present in a way that makes the audience interested in what you are saying. (5 points)

Individual grade:

- You are graded on the same items as above, but the grade applies to your individual part of the presentation. Everyone is required to attend the presentations.

**Software**

This course uses CORE, which is available only for Windows. See MBSE Software folder in Course Content on Blackboard**.** The software is installed in the Volgenau School open lab (ENGR 1506) and hours for the lab are on the VSE Labs site (http://labs.vse.gmu.edu). If you have a Macintosh computer and want to install the software on it, you will have to use either a virtual machine or BootCamp to install Windows on your Macintosh computer. VMWare Fusion and Windows are available at no charge through your enrollment in Volgenau School courses. Instructions for obtaining the software are in the Microsoft DreamSpark & VMWare FAQs on http://labs.vse.gmu.edu

**Administrative Items**

*Electronic Communication*: Your George Mason email will be used for communication related to the course. You are responsible for checking email daily. If you don't use your gmu.edu email regularly, make sure you have your email forwarded to an address you check regularly, and check periodically to make sure you have not exceeded your quota.

I can be contacted at lferreir@gmu.edu. Please make sure you include SYST 210 in the subject line of your email. Otherwise, I cannot guarantee that I will respond to your email due to the large volume of email I receive.

*Academic Integrity*: GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

*Mason Diversity Statement:* George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth.

An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

The reflection of Mason's commitment to diversity and inclusion goes beyond policies and procedures to focus on behavior at the individual, group and organizational level. The implementation of this commitment to diversity and inclusion is found in all settings, including individual work units and groups, student organizations and groups, and classroom settings; it is also found with the delivery of services and activities, including, but not limited to, curriculum, teaching, events, advising, research, service, and community outreach.

Acknowledging that the attainment of diversity and inclusion are dynamic and continuous processes, and that the larger societal setting has an evolving socio-cultural understanding of diversity and inclusion, Mason seeks to continuously improve its environment. To this end, the University promotes continuous monitoring and self-assessment regarding diversity. The aim is to incorporate diversity and inclusion within the philosophies and actions of the individual, group and organization, and to make improvements as needed.

*Student Support Resources*: Here is a link to resources you may find helpful:

http://ctfe.gmu.edu/teaching/student-support-resources-on-campus/

**Course Content on Blackboard: Lecture Notes**

All course lecture notes are available at any time

**Course Content on Blackboard: Supplementary Materials**

Includes tutorials and study guides for midterm and final

**Other Readings on Blackboard**

Includes history systems engineering, modern case studies

**Class Schedule and Assignments**

| Class | Subject and items covered | Assignment due at beginning of class (Reading, Project, Homework) |
|---|---|---|
| 1: Jan 21 | Lecture Unit 1: Introduction & Course Overview | None |
| 2: Jan 28 | Quiz 1: SE Basics<br><br>Lecture Unit 2: Overview of the SE Design Process | **Readings**: Lecture Notes: Unit 2; Buede: Chapters 1 (Introduction), 2 (Overview), 6.3 (Requirements Definition), 6.10 (Operational Concept) and 6.11 (External Systems Diagrams); Friedenthal: Chapters 1 (Overview) and 2 (Model-Based SE) [or OMG SysTutorial Slides 1-13, MBSE Tutorial Slides 1-11, MBSE Course sections 1a to 1d]<br><br>***HW Assignment 1 Intro*** |
| 3: Feb 4 | Lecture Unit 3: Operational Concept and External Systems Diagram<br><br>In-class CORE lab work (begin HW Assignment 3 in class)<br>- Introduction to CORE<br>- Sequence Diagram<br>- External System Diagram in CORE | **Readings**: Lecture Notes: Unit 3 Buede: Chapter 3 (SysML Modeling), Friedenthal: Chapters 3 (Getting Started with SysML) and 12 (Use Cases) [or OMG SysTutorial Slides 59-60, MBSE Tutorial Slides 52-62, MBSE Course section 3a]<br><br>***HW Assignment 2 User Needs and Operational Concept***<br><br>***Project Deliverable 1 (Description, References, and Project Plan)*** |
| 4: Feb 11 | Quiz 2: Operational Concept and External Systems Diagram<br><br>Lecture Unit 4: Working in Teams<br><br>Team discussion for HW Assignment 4<br><br>In-class CORE lab work (begin HW Assignment 4 and Project Deliverable 3 in class) | **Readings**: Lecture Notes: Units 4 and 5<br><br>***HW Assignment 3 Teams*** |

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| 5: Feb 18 | Quiz 3: Teams<br><br>Lecture Unit 5: Objectives Hierarchy and Requirements | **Readings**: Lecture Notes: Unit 5<br>Buede: Chapter 6 (Requirements)<br>Friedenthal: Section 8.11 (Modeling Evaluations of Trade Studies) and Chapter 13 (Modeling Text-Based Requiements) [or OMG SysTutorial Slides 65-67, MBSE Tutorial Slides 40-51, MBSE Course sect. 4a]<br><br>***HW Assignment 4 Using Core***<br><br>***Project Deliverable 2 (Draft Statement of Need, Operational Concept and External Systems Diagram)*** |
| 6: Feb 25 | Lecture Unit 6: Defining the Functional Architecture<br><br>Midterm Review | Quiz 4: ESD (External Systems Diagram)<br><br>**Readings**: Lecture Notes: Unit 6<br><br>***HW Assignment 5 Midterm Preview*** |
| 7: Mar 3 | **Midterm exam**<br>Note: Midterm covers Units 1-5 and part of Unit 6 | |
| **Mar 10** | **NO CLASS – GMU SPRING BREAK** | |
| 8: Mar 17 | Discussion of Midterm<br><br>In-class CORE lab work (begin HW Assignment 6) | **Readings**: Lecture Notes: Unit 6<br>Buede: Chapter 7 (Functional Architecture)<br><br>***Project Deliverable 3 (Draft Objectives Hierarchy and Originating Requirements)*** |
| 9: Mar 24 | Quiz 5: Functional Architecture<br><br>Lecture Unit 7: Physical Architecture<br><br>In-class CORE lab work (begin HW Assignment 7) | **Readings**: Lecture Notes: Unit 7<br>Buede: Chapter 8 (Physical Architecture)<br><br>***Midterm rework***<br><br>***HW Assignment 6 Objectives and Requirements*** |
| 10: Mar 31 | Quiz 6: Physical Architecture<br><br>Lecture Unit 8: Allocated Architecture<br><br>In-class CORE lab work (begin HW Assignment 8) | **Readings**: Lecture Notes: Unit 8<br>Buede: Chapter 9 (Allocated Architecture)<br><br>***HW Assignment 7 Functional Architecture*** |

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| 11: Apr 7 | Lecture Unit 9: Interface Design<br><br>In-class CORE lab work (begin HW Assignment 9) | **Readings**: Lecture Notes: Unit 9<br>Buede: Chapter 10 (Interface Design)<br><br>***HW Assignment 8 Physical and Allocated Architecture*** |
| 12: Apr 14 | Quiz 7: Interface Design<br><br>Lecture Unit 10: Decision Analysis for Trade Studies | **Readings**: Lecture Notes: Unit 10<br>Buede: Chapter 13 (Decision Analysis for Design Trades)<br>***Project Deliverable 4 (Draft Functional, Physical, and Allocated Architectures)*** |
| 13: Apr 21 | Quiz 8: System Qualification Lab<br><br>Lecture Unit 11: Integration and Qualification<br><br>***Project Presentations (First Group)*** | **Readings**: Lecture Notes: Unit 11<br>Buede: Chapter 11 (Integration and Qualification)<br><br>***Project Deliverable 5 (Draft Project Report)***<br><br>***Project Presentations are DUE for ALL groups***<br><br>***HW Assignment 9 Qualification*** |
| 14: Apr 28 | ***Project Presentations (Second Group)***<br><br>Final Review | ***HW Assignment 10 Final Exam Preview*** |
| 15: May 5 | **Final Exam** NOTE TIME: **1:30 pm – 4:15 pm** | ***Project Deliverable 6 (Final Project Report)*** |