SE3100 Fundamentals of Systems Engineering

This syllabus is your course guide. It contains the following sections:

1.0 Instructor

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2.0 Goal

After completing this course, you will be able to apply the fundamentals of systems engineering including:

- Systems Architecture and Engineering as a framework for approaching problems
- and the integration of creative thinking with analytical skills to develop and analyze system solutions to provide new or improved capabilities for the stakeholders.

3.0 Course Description

The course covers fundamentals of systems engineering. It is an introduction to systems thinking and the processes and methods of systems engineering. Topics include system architecting, requirements analysis, functional analysis and allocation, preliminary system architecture, systems analysis, system design, and the basics of test and evaluation. The course also addresses specific DoD systems engineering processes, as well as the DoD life-cycle acquisition framework. Various perspectives, from frameworks, processes, and standards, such as the DoD Architecture Framework (DODAF), DoD Joint Capabilities Integration and Development System (JCIDS), EIA 632, ISO 15288, IEEE 1220, IEEE 1471, and the International Council on Systems Engineering (INCOSE) models, are presented. Students analyze case studies. Students also use spreadsheet software for modeling and analyzing requirements and conceptual design

alternatives. Students model and analyze requirements and conceptual design alternatives. The course includes the application of fundamental systems engineering processes and methods to an integrative project, as well as development of communication skills through oral presentations and written reports.

4.0 Learning Outcomes

Upon successful completion of this course, you will be able to:

- Define systems engineering, including its purpose and scope and the role of the systems engineer.
- Define systems architecting, including its purpose and scope and the role of the systems architect.
- Apply the fundamentals of a systems engineering process appropriately across a system's life-cycle.
- Elicit, elaborate and document system requirements based on user needs and operational objectives; translate them to technical requirements.
- Create a system value hierarchy reflective of stakeholder goals.
- Complete system functional analysis in support of requirements engineering using modeling tools such as IDEF0, FFBD and other techniques.
- Develop, evaluate and document alternative system architectures, using DoDAF products where appropriate.
- Plan for system validation, to ensure technical performance measures map to operational characteristics.

5.0 Course Format

This course is divided into weeklong segments consisting of:

- **Online modules.** The material for the course has been organized into weekly self-contained modules. Each module will list required reading and assignments. Some modules have prerecorded lectures. This course will be supplemented by use of asynchronous technology for support. It is expected that you will use our commercial web-based distributed-learning support tool Sakai (accessed via https://cle.nps.edu).
- **Lectures.** Your instructor will host weekly lectures. These lectures may be augmented by prerecorded lectures conducted by other professors. These prerecorded lectures are located in the weekly module. The lectures are mandatory but the session will be recorded so the students can watch at a later time via Elluminate. If you need some help with Elluminate, there is some helpful information at www.nps.edu/Technology/Elluminate/index.html.
- **Discussion forums.** These forums are in Sakai. You are expected to collaborate with colleagues to discuss various aspects of systems engineering, as assigned by the instructor. You should post an original thought and then comment on at least two other students' posts. Your original thought is critical; you should read the assignment then formulate your response without being biased by other student input.
- **Lab sessions.** The course is a 3/2 hour course. This means there are 3 hours of lecture in class and 2 hours of lab out of class. This portion of the class is not scheduled but is where you learn and practice working with the methods and techniques of systems engineering on

a real system. You will have CORE labs and a CORE assignment. The course project is another assessment method used for the weekly labs. The class will be separated into small groups to execute the course project. Weekly deliverables will be due from the group to the instructor. Group forums will be established to enable the students to work together.

6.0 Expectations

The expectation is that you will be active, skilled participants in course learning. Participation in class discussions is a key to success, especially with regard to developing critical thinking skills. Passively observing your classmates or instructor will lead to poor performance – interaction is the key because it's not just "info download!" Your efforts should demonstrate a mind taking charge of its own ideas, assumptions, inferences, and intellectual processes. You are responsible for all material covered in class. In general, it is preferable to use direct email to me as a means of communication for direct questions that may have little relevance for the rest of the class. For issues that may be of relevance to the rest of the class, I have established an on-line discussion board forum called "Ask the Prof" in the Discussion Forums area of Sakai.

The lecture in each module represents 2-3 hours of class time, the reading usually requires 2-3 hours, and the assignments and other activities can take up to 6 hours. That's 10-12 hours per week. Your weekly work flow should be: open the module for the week > read the introduction and learning objectives > read the required material (textbook or other hand-outs) > participate in the lecture > do the assignments. It is expected that you will do your own work and submit only your own work for examinations and homework, unless otherwise indicated for a specific item.

Working in small groups, students will complete a quarter-long design project to demonstrate mastery of course material and to apply course concepts to a real-world system. Students prepare both written reports and briefings on their results.

From me, you should expect fair treatment and application of the policies outlined in this syllabus; an opportunity to actively interact with me and your classmates every class meeting; and demonstration of engineering reasoning and intellectual humility. Also, I will try to provide something new of immediate practical utility every week.

Office Hours. I will not have a specific office hour time. I am available most days from 0500 to 1900 eastern. I do teach other classes and am taking other classes, but check my email often.

7.0 Weekly Topics

Assignments and activities will be given each week. Time required to complete course readings and assignments is generally **4-6 hours per week,** this does not include the 2 hour weekly lab sessions that will be conducted to support the course project.

To accommodate the needs of individual participants through a distributed learning model, this course is primarily an online experience using significant synchronous and asynchronous delivery and interaction methods.

It is essential that you have the **minimum amount of time** to devote to this course and that you are **available** to attend or view the required sessions. This is a "student-centered" and group-paced course that requires your attendance, timely participation, peer review and feedback.

We learn from each other in this model, it's not just an "info download!"

Two "milestones" are identified in the course schedule. Meeting a milestone means you have attended or viewed scheduled sessions, participated in online activities, and turned in assignments to date. Completion of requirements at each milestone will help you stay on track and help the instructor ensure your successful completion of the class and the lab exercise. Weekly activities are described on the course Sakai site.

Module	Begin Date	Class Date	Topic	Reading	Graded Event	due date	Points
					Lab 1 Download	11-Jul-11	
1	5-Jul-11	6-Jul-11	Introduction: Systems, Systems Thinking, Systems	B&F Ch 1, 2	Discussion Forum 1	11-Jul-11	5
					Assignment 1	11-Jul-11	10
					Lab 2 CORE Intro	18-Jul-11	
2	12-Jul-11	13-Jul-11	Requirements Analysis; Operational Concept Definition	B&F Ch 3 and Handouts	Discussion Forum 2	18-Jul-11	5
					Project Assignment 2 Reqs & OCD	18-Jul-11	10
					Lab 3 Reqts & Context	25-Jul-11	
3	19-Jul-11	20-Jul-11	Stakeholder Analysis and VSD	B&F Ch 4 and Handouts	Discussion Forum 3	25-Jul-11	5
					Project Assignment 3 VSD	25-Jul-11	10
4	26-Jul-11	27-Jul-11	Functional Analysis	B&F Chp 3, 4, App A and Handouts	Lab 4 Func Analysis	1-Aug-11	
					Assignment 4 CORE	8-Aug-11	10
5	2-Aug-11	3-Aug-11	IPR 1	Project Guidance	Project Assignment 5	3-Aug	15
	04-Aug-11		***MS1***		Practice Exam	14-Aug-11	5
					Record Exam	14-Aug-11	15
			System Architecture	B&F Ch 3.7.3			
6	09-Aug-11	10-Aug-11			Discussion Forum	15-Aug-11	5
					Project Assignment 6	15-Aug-11	10
7	16-Aug-11	17-Aug-11	DoDAF		Discussion Forum	22-Aug-11	5
				Handouts	Project Assignment 7	22-Aug-11	10
					Discussion Forum	29-Aug-11	5
8	23-Aug-11	24-Aug-11	System Design and Synthesis	B&F Chp 4	Project Assignment 8	29-Aug-11	10
				Handouts			
					Discussion Forum	5-Sep-11	5
9	30-Aug-11	31-Aug-11	Analysis and Tradeoff	B&F Ch 7	Project Assignment 9	5-Sep-11	10
				Handouts			
10	06-Sep-11	07-Sep-11	Integration, Test and Evaluation	B&F Ch 6 Handouts	Discussion Forum	12-Sep-11	5
			MS2				
			Last NPS class		**All Individual Work**	**14-Sep-11**	
Final Exam Week	13-Sep-11		IPR2	Project Guidance	Project Brief Due	14-Sep-11	15
					Report	17-Sep-11	25
					Project DB	17-Sep-11	5
					Total		200

Table 1 Weekly Schedule

8.0 Prerequisites

Engineering and mathematical background is beneficial, but not required.

For those students seeking equivalency for DAU courses, DAU's on-line course ACQ101 must be completed before this course.

9.0 Technical Requirements

A working knowledge and proficiency with basic computing and office automation is required. This is defined as the ability to:

- organize and manage files and folders in your operating system;
- receive and submit electronic course materials;
- effectively use (create, format, edit, save, and distribute documents) a word processing program, typically using MS Word or compatible format;
- send and receive e-mail (including attachments); and,
- navigate, search, download, and execute files from the Internet.

Recommended technical specifications: You will be able to access the course materials using your campus or home computer as long as you are able to connect to the Internet.

It is recommended that you have a PC with a minimum of 128 Megabytes of system memory (RAM). It is also recommended that you have a microphone to use for the Elluminate sessions. Chatting is available, but a microphone will enable the student to ask questions and provide input in real time.

NPS recommends using **Internet Explorer (version 6)** as your Web browser to access the online portions of the course delivered through the Sakai learning support system. If you prefer to use other Web browsers, see the recommendations for versions located in the Syllabus section of the Sakai site.

Some materials may be provided in Adobe portable document format (PDF) that will require you to have a free "Acrobat Reader 6.0" on your computer (available for download at http://www.adobe.com/acrobat). Interactive components in the online modules require the Flash player. Flash 7 is available for free download at the Macromedia download site.

If you have software issues or need instruction to meet the prerequisite technical experience, contact Information Technology & Academic Computing Support (ITACS) Technology Assistance Center (TAC) for assistance.

Email: TAC@nps.edu
Telephone: (831) 656-1046
Location: Ingersoll Hall, Room 151
Hours: Monday - Friday, 8:00 a.m. to 4:30 p.m.
Training Services: http://www.nps.edu/Technology/Navigation/TrainingSrv.html

10.0 Textbooks

Systems Engineering and Analysis, Blanchard, B. S. and , W. J. Fabrycky, Prentice-Hall International Series in Industrial and Systems, 5th Edition, ISBN 978-0-13-221735-4, 2010

Engineering Reasoning: The Foundation for Critical Thinking, Richard Paul, Robert Niewoehner and Linda Elder, ISBN 0-944583-33-4, 2006. (mailed by NPS's Center for Educational Design, Development and Distribution (CED3))

11.0 References

Excerpts from these and other references will be provided in Sakai

International Council on Systems Engineering (INCOSE) SE Handbook, Version 3.2 Feb 2010, INCOSE

Defense Acquisition Guidebook

12.0 Evaluation

The evaluation scheme of this course is outlined in the following table.

Graded Event	QTY	Pts each	Total
Individual Assignments	4	10	40
Module Discussion Forums	8	5	40
Midterm	1	20	20
Project IPR1	1	15	15
Team Project Assignments	4	10	40
Final Project	1	45	45
Total			200

Table 2 Course Evaluation

Homework & Class Participation

A seminar approach to learning is essential to this course. You are responsible for preparing to engage in discussion by completing the readings as outlined in the syllabus. Some modules have suggested topics for discussion. Draw on your experiences and bring that to discussions, framed by the readings. Additionally, you will perform a number of class participation exercises such as role-plays and problem solving. Submission of your results is mandatory. Details are provided in each module. Also, the assignments are designed to be supportive of the class project.

Examinations

There will be only one exam given during the course. The exam will be used as a measure of the student's understanding and application of the concepts covered during the course. Preparation for the exams will best be accomplished by completing the readings, homework assignments,

and team project, and by participating in the class meetings and discussions. The exams are not intended to test the student on rote memorization, but to assess how well the systems engineering concepts are understood and tied together. Waiting until just before the exam and cramming will not be effective. It will be mostly composed of multiple-choice questions; open book; open notes; one hour; on-line. More details will be provided just before the exam. Additionally, if a student earns a score of less than 60% on either exam, he will receive a grade of "D" for the course, regardless of other work.

Class Project

The class will be divided into teams of 5-6 persons and assigned a project that requires application of the concepts and skills learned in class to a "real world" systems engineering problem. Each design team will complete two In-Progress Reviews (IPRs). The deliverable for these reviews is a presentation (not more than 25 slides, excluding back-up). The first will be about mid-way through the course and the second during Finals week. Additionally, each team will submit a written Design Report at the end of the quarter. I have an "all for one" grading policy with group work. That is, the final deliverable is graded, and each group member receives that same grade. Do **not** be a sea-anchor to your classmates – pull your share! To help you stay focused on that, I require that you use your team's Discussion Forum on Sakai to exchange information with each other. I will periodically review who is posting material and I will have a chat with those who appear to be slacking.

13.0 Online Participation Criteria

Participation is a critical part of a dynamic and interactive online learning experience. In addition to completing activities, such as reading, case studies, and completing Lab exercises, you will engage with the online content and participate in asynchronous discussions with other class participants. I recommend logging on to the Sakai course site at least 3 days each week. This strategy of frequent participation in online courses is found to be most effective in improving retention and completion rates…a little every day gets the job done! It assists you in time management, and provides a structure and incentive to remain "connected" to the class.

The grading system for the On-line Participation (*e.g.* Discussion Forums, *etc*.) portions of the course is somewhat different from most classes, since there is no absolutely right or wrong answer. You will get a quantitative assessment of your participation, however. As a part of the assessments for each forum, your contributions in the online discussion will be assessed as follows:

The following 5 point grading scale is used and is reflective of the self-consistency and depth of your answers and the thoughtful incorporation of materials from class and assigned readings. Note that a grade of 3 is given for an answer that corresponds to an average, expected answer. The grades 4-5 are used for above average answers, the grades 1-2 for below average answers.

1. Did not really capture intent of exercise, missed main points.
2. Captured some, but not all of the important points, but could have been better.
3. Workmanlike discussion, following and applying the ideas presented in modules and readings.

4. Very good discussion, which captures the main points and presents a thorough analysis of the issues.
5. Excellent discussion, which captures all of the important points, and adds creative new perspectives of view above and beyond those contemplated by the instructor.

Sixty percent (3 points out of 5 per discussion forum) of the grade is awarded based on a determination of the quality of your contributions to the online discussions based on these criteria:

- Is your contribution clear? Did you accurately and clearly address the essence of the question or comment?
- Are your comments supported by, and connected to, references in the text, modules or other research? The more you can make connections between resources and your experience and opinion, the more transformational your learning will become.
- Did your comment/answer add a new insight or something useful to the discussion? Use examples and relate to experiences that illuminate additional aspects of the topic. Don't be afraid to state dilemmas or areas that you are leaving open to further exploration--that indicates an open mind. You will be learning about tools and knowledge in the context of larger values, and your experiences and opinions are vital. Everyone in this class is called upon to be a student AND a teacher, a leader AND an enthusiastic team member.

Forty percent (2 points out of 5 per discussion forum) are awarded for responses you post that comment on other participants' comments, such as answers to a question, or comments on a point raised.

14.0 Late Policy

Assignments, Discussion Boards, and Projects include specific due dates to facilitate the pacing and interaction in the course. Your attention to the dates will contribute to an effective learning community and insure that you and your colleagues are able to help one another build and improve your knowledge. Points will be deducted, and at times late accomplishment will result in a zero grade, for assignments that are not submitted by the requested dates, unless **prior** arrangements have been made.

As described in the Course Format section, **two "milestones" are identified in the course schedule**. Meeting a milestone means you have attended or viewed scheduled sessions, participated in online activities, and turned in assignments to date. Completion of activities at each milestone is required to continue to the next phase of the course.

NPS Honor Code

NAVAL POSTGRADUATE SCHOOL HONOR CODE (ref: NAVPGSCOLINST 5370.1D)

Academic integrity at the Naval Postgraduate School is based on a respect for individual achievement that lies at the heart of academic culture. Every faculty member and student belongs to a community of scholars where academic integrity is a fundamental commitment. Academic dishonesty is not tolerated.

Unless otherwise stated by the instructor: all in-class work submitted for a grade will be the student's own, performed without reference to materials or other individuals.

Graded work assigned for completion outside the classroom allows the use of reference material, but shall be performed without the assistance of other individuals. To be more specific, take home tests or exams for resident students or assignments and exams for distance learning courses shall be students' own original work. There shall be absolutely no assistance from any other person by any means including, but not limited to: conversation; copying written work; phone conversations; or any electronic communication. All books, notes, and on-line sources that do not involve interaction with a person may be used. All written work should appropriately identify referenced material. This default policy for take home tests or exams is in force unless other specific instructions are provide by the faculty member in charge of the course.

While no single list can hope to identify and define all types of academic honor code standards, the following are cited as examples of unacceptable behavior:

Cheating. Using unauthorized notes, study aids, or information on an examination; looking at another student's paper during an examination; altering a graded work after it has been returned, then resubmitting it for regrading; allowing another person to do one's work and submitting it under one's own name.

Plagiarism. Submitting material that in part or whole is not entirely one's own work without attributing those same portions to their correct source.

Fabrication. Falsifying or inventing any information, data, or citation.

Obtaining an Unfair Advantage. Gaining access to examination materials prior to the time authorized by the instructor, unauthorized collaboration on an academic assignment; possessing, using, or circulating previously given examination materials where those materials clearly indicate that they are to be returned to the instructor at the conclusion of the examination.

Aiding and Abetting Academic Dishonesty. Providing material, information or other assistance to another with knowledge that such aid could be used in any of the unacceptable behaviors described above; failure to address observed violations of this code.

Falsification of Records and Official Documents. Altering documents affecting academic records.