



# Fundamentals of Systems Engineering

## SE3100

Lecture: Course Overview

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NAVAL  
POSTGRADUATE  
SCHOOL





# Topics

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- Course Overview
  - Topics
  - Calendar
- Graded Events
  - Discussion Boards
  - Assignments
  - Project
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- Administration
  - Sakai
  - Office hours
  - Text books
- Course Project Overview
- CORE introduction

# Contact Information

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  - NPS E-mail
    - [btkwinn@nps.edu](mailto:btkwinn@nps.edu)
- I live in New York





# Professional Experience

- Academic
  - M.S. Systems Engineering University of Arizona
  - B.S. United States Military Academy, West Point
  - Ph.D. student at Stevens Institute of Technology
- Teaching
  - West Point, 1994-1997
  - West Point 2002-2006
  - NPS since July 2008
- Background
  - Retired US Army Officer
    - Logistician
    - Operations Research/Systems Analyst
    - Systems engineer- design
  - Acquisition experience
    - Analysis of alternatives, technology development
    - Operational testing



# Introductions

- On the discussion forum in Sakai
- Background
  - Where from
- Education
  - School
  - Major
- Experience
- What are you famous for?





# SE Core Skill Requirements

In addition to traditional core disciplines, *a broad-based, design oriented educational background focusing on development, implementation, and optimization of complex technological and non-technological systems.*

- Identify, formulate, and solve engineering and/or technical problems
  - Research, design, development, procurement, operation and/or maintenance in scientific and/or technical engineering fields
- Understand impact of engineering and/or technical solutions in global context
- Interact with personnel from industry, laboratories, academic institutions and/or other services regarding system design, maintenance, and operation
- Use techniques, skills, and modern engineering tools for engineering practice, including the ability to analyze and interpret data
- Develop policy and procedures through entire spectrum of operation
- Apply knowledge to the design, procurement and maintenance of ships, boats, craft and related systems
- Prepare technical and/or operational briefings, project plans, and reports



# Intended Audience

This course is intended for DoD system designers, program acquisition professionals, URL, and others who need to understand how to think in a “big picture” way for system development using systems engineering and analysis methods.



# Systems Engineering Certificate

- Concentrate on Engineering Aspects
  - SE3100 Fundamentals of Systems Engineering
    - Equivalency SYS101, SYS202 & SYS203, if you take ACQ101 and earn at least a “B” here
    - You apply for equivalency through DAU with NPS transcript
  - SE in Depth
    - SE3302 Systems Suitability
    - SE3303 Systems Assessment
- Project Management
  - SI3400 Fundamentals of Engineering Project Management (equivalency of SYS302)





# Course Outline

- One Quarter (10 Weeks)
  - Systems Thinking
  - Systems Engineering
  - Systems Architecting
- Weekly (See course syllabus for details)
  - 3 hrs lecture
  - 2 hrs 'lab' or 'project' in group (outside of class hours)
  - 5-7 hours assignments
    - Discussion boards (1-3 hours)
    - Individual assignments (1-3 hours)
    - Reading (1-3 hours)
    - Team project individual work (1-3 hours)
- Expected 10-12 hours of work each week!
  - Graduate level course
  - ABET accredited for MSSE



# Course Description

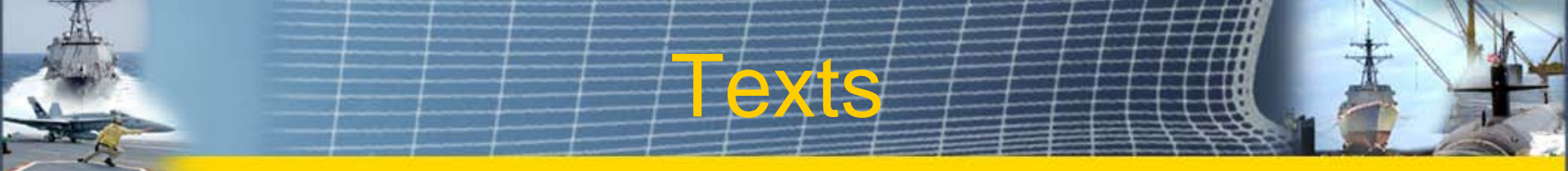
- This course is an introduction to **systems thinking** and the **processes and methods of systems engineering**.
- The course covers **fundamentals of systems engineering** and system architecting, requirements analysis, functional analysis and allocation, preliminary system architecture, systems analysis, 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.



# Goals for SE3100

- Introduce you to the fundamentals of systems engineering including:
  - Systems Architecture & Engineering as a framework for approaching problems
  - Integration of creative thinking with analytical skills
- Learn keys to success
  - Requirements definition and management
  - Functional analysis
  - Architecture use
  - Alternatives analysis
  - T&E basics
  - Tools to bring order to chaos
- Practice in a controlled environment

**Apply these concepts in developing & analyzing system solutions.**



# Texts

- *Systems Engineering and Analysis*, Blanchard, B. S. and , W. J. Fabrycky, Prentice-Hall International Series in Industrial and Systems, 5<sup>th</sup> Edition, 2010
- Uses several other documents
  - Richard Paul, Robert Niewoehner and Linda Elder. *Engineering Reasoning*. The Foundation for Critical Thinking. 2006. ISBN 0-944583-33-4
  - On Sakai
    - DODAF, v1.5 and v2.0
    - INCOSE Systems Engineering Handbook, Version 2a and 3.2
    - DAU SE Fundamentals Handbook, 2002
    - Other various readings from DoD and industry

References on Sakai that are copyrighted are provided for your academic use only.



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





# Graded Events

- Individual assignments
  - Submit via Sakai
- Discussion forums
  - Minimum 3 posts, original thought then 2 other comments
- Project
  - Throughout the quarter
  - Individual and Team event
- Examinations
  - Individual work, open book, not timed
  - Midterm exam (1+ weeks to complete)
  - No final exam
- Graded event feedback
  - Try to grade the day after submission
  - Feedback provided Sakai gradebook
  - Team assignments feedback provided to the team lead and project systems engineer



# 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.



# My Method

- You read the reading
- You participate in lecture
  - What I present
    - Different content then reading and recorded lecture, slides will be posted before Monday
    - Compliment reading and recorded lecture
    - INCOSE or other view of SE
    - Read the slides because they are the content for the DAWIA
  - You can ask questions, call in, send email etc
- You review the recorded lectures
- You do the assignments
  - Assignment
  - Discussion forum
  - Project



# Admin

- Students
  - Large class
  - From all over
  - MSSE Cohort
- Assignment format
  - Last name on submissions
  - Last name in file name
  - Submit to Sakai
    - Email as last resort
    - If you email, I forget to grade
- Python
  - Student opinion forms for classes
  - Official grades
  - Add/drop



# More Admin

- Office hours
  - I try to be available 7 days a week
  - Weekdays 0600-1900 Eastern time (not continual)
  - Weekends a few hours a day
  - Email me or call me but first ask your classmates on the Sakai DB!!!





# Overview of Class Project

Mobile Contingency Operating Base  
Protection



# Use of CORE

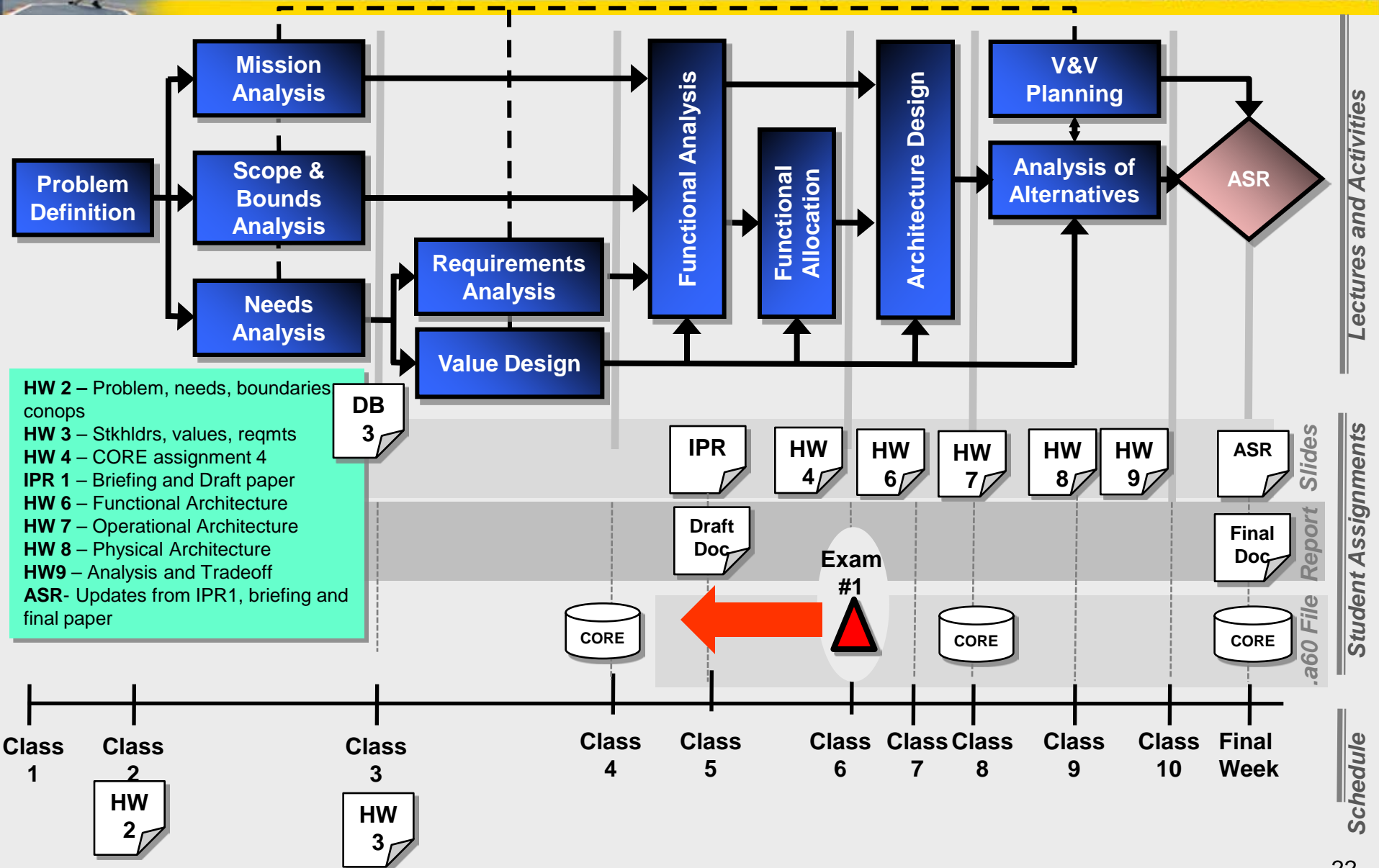
- Using CORE in support of class project is mandatory
- Download instructions in project document on Sakai
- “CORE Labs 1-4” documents are a companion to the Vitech Guided Tour
  - 4 self-paced labs
  - Tips & tricks
  - 1 graded assignment (Module 4)



# Design Project Overview

- Apply our SE Process
  - “Real World” problem
  - Scaled down
- Problem Definition is sometimes the most difficult, but always the most important phase!
- Individual homework and team event
- Team graded events
  - Two graded briefings
  - Final report

# Class Project SE Process





# IPR 1 – Problem Definition

- Problem background
- Effective Need
- Define the capability needs
- Threat analysis
- Operational concept
- Boundaries and external interfaces
- Stakeholder analysis
- Value system
- Requirements summary
- Summary of your analysis and next steps





# ASR – Alternatives Review (IPR2)

- Review IPR #1 with changes
- Functional analysis
- Alternatives descriptions
- Analysis of alternatives
- Physical architecture
- T&E strategy
- Summary



# Final Report Outline

- Introduction
  - Background on the problem
  - Assumptions
  - SE Process
- Problem definition
  - Needs, problem analysis, boundaries
  - Operational Concept
  - Stakeholders & value design
  - Requirements analysis
- Functional analysis and allocation
  - Architectural design
  - Alternatives
  - Trade-offs and analysis
- T&E strategy
- Lifecycle Cost Estimate



Report  
Template



# Customer Basic Need

In July 2010, several US troops were killed in a coordinated attack by insurgents on a remote base in Afghanistan. Some means to improve defense against these kinds of coordinated attacks in remote areas is needed. While there are several sensor and weapon systems that could provide this functionality, they are either ineffective or require infrastructure that is not available. Further, they are not integrated with each other or with existing C2 systems. An integrated sensor-to-shooter support system that is portable and self-sufficient is required.



# Constraints

- The security system must be mobile, deployable, and transportable by a team of 10 or fewer personnel and set up within 24 hours.
- The system must not degrade the security posture of the bases, being integrated with existing defensive TTP.
- Minimize the number of sub-systems needed
- Use existing systems and technology, with initial deployment in 18 months



# Assumptions

- Airspace is considered “owned” by US and allies, making air defense outside the scope
- Combat troops at the bases are well-trained with will be considered part of security operations
- Communications and C2 systems exist at the bases
- The system must abide by the international law of armed conflict
- Some changes to TTP may be necessary





# General Guidance

- Role play the stakeholders
- Research the threat
- Research FOBs & COBs
- Research the available systems and technology
- Be creative!!
- Exercise systems thinking & consider non-materiel solutions
- Employ SE methods and processes



# First Step (for each team)

- Teams
- Define the roles and rules of engagement of the team
- Choose a team name
- Team collaboration
  - Team folders will be created in Resources
  - Team Elluminate sessions created so you can talk and share
  - Team Discussion Forums created



# Team List



# Sakai Overview

- Syllabus
- Schedule/calendars
- Modules
  - Recorded videos
  - Ppts
  - Whiteboard notes
  - Discussion forums
  - Assignments
  - Exams
- Grade center
- References
- Elluminate

# CORE Overview







# *How will this course be different?*

- The Systems Architecture & Engineering is an “**organized approach to creativity**”
- Unlike most of your previous courses, there is **seldom an “approved solution”**
- Instead of memorizing formulas, equations, rules, etc., SE3100 teaches a **process** which can be applied many different ways

This is a course on “*How* to think”, not “*What* to think”



# Expectations

- Think Creatively
  - This is a course on “*How* to think”, not “*What* to think”
- Communicate
  - With each other
  - With me

# SE Professional Society



INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING



- Membership
  - Local Chapter Networking
  - Annual International Symposium
  - Journal
  - Newsletter
  - SE Certification
  - SE Handbook – *free!*



# Remember

- Working on Sakai site
  - If you have link problems, let me know
- Survey course cover required content
- NPS technical assistance center (TAC)
- 10 hours/week minimum!



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