

To: IPFW Senate
From: Judith Garrison, Graduate Subcommittee
Date: October 29, 2008
Re: Proposal for Graduate Certificate in Systems Engineering

Graduate Subcommittee supports the proposal for Graduate Certificate in Systems Engineering, and finds that the proposal requires no Senate review.

Approving

S. Carr
T. Downy
J. Garrison
A. Livschiz
Y. Zubovic

Not Approving

Absent

P. Bingi
B. Fife
G. Hickey
L. Hite

IPFW
Request for a New Credit Certificate Program

Campus: Fort Wayne

Proposed Title of Certificate Program: Graduate Certificate in Systems Engineering

Projected Date of Implementation: Fall 2008

I. TYPE OF CERTIFICATE: (check one)

UNDERGRADUATE CERTIFICATES – These programs generally require 12-29 credits of undergraduate-level academic work.

GRADUATE CERTIFICATES – These programs generally require 12-29 credits of graduate-level academic work or undergraduate academic work carrying graduate credit.

POST-BACCALAUREATE CERTIFICATES –These programs generally require 12-29 credits of undergraduate-level academic work, although students enrolling in these programs must have completed their baccalaureate degrees.

II. Why is this certificate needed?

Systems engineering is a structured approach to developing technical solutions that satisfy customer needs. Unlike traditional forms of engineering (*i.e.* electrical, mechanical, etc.) systems engineering does not focus on a specific class of products or technologies; rather it focuses on processes used to design, develop, verify and validate new products and systems.

Systems engineering “best practices” reduce development budgets and schedules, enhance product quality and ensure that products will meet customer needs. In other words, good systems engineering will improve a company’s bottom-line. With these benefits, it is not surprising that many companies are investing in their systems engineering capabilities. In fact, local industry has established a distinguished systems engineering faculty position at IPFW to increase their access to needed educational training and course work. This industry-university partnership has also led to the systems engineering focus in the recently-approved IPFW Master of Science in Engineering (M.S.E.) program. The required graduate-level course work for the systems engineering certificate is designed to teach a robust approach to product development from concept definition to the development of the first production article. Students enrolled in these courses will learn best practices, gain familiarity with industry and government standards and develop a toolbox of techniques to guide and manage their product development efforts.

Local interest in the program is high. In spring 2006 and fall 2007, the department offered a course equivalent to SE510 Systems Engineering. The spring 2006 was given by a consultant through IPFW Continuing Education and attracted thirty students; this semester (*i.e.*, fall 2007) it is being offered by an engineering professor and has an enrollment of nineteen students. The enrollment numbers are impressive considering that the M.S.E. program has not admitted its first class. (The first class will be admitted in spring 2008.) Thus, the majority of the students were admitted with *temporary, post-baccalaureate* status and they were not eligible for university-based financial aid.

During the development of the M.S.E. proposal, the Department of Engineering surveyed local employers to define program options and course offerings. In addition to considerable interest in the Master of Science in Engineering, there was interest in a systems engineering graduate certificate. The certificate program would address the needs of working engineers that already possess a master's degree and students that either do not have the time or financial resources to commit to the M.S.E. program.

III. List the major topics and curriculum of the certificate.

The Graduate Certificate in Systems Engineering is based on the core courses for the systems engineering area of specialization within the IPFW Master of Science in Engineering (M.S.E.) program. The courses are designed to provide a broad background in systems engineering techniques and practices including:

- Systems engineering processes and standards
- The stages of both the project and product lifecycles
- A process for scope definition
- Definition, allocation, derivation and management of requirements and specifications
- Techniques for performing functional analysis and allocation
- A framework for constructing and evaluating system trades
- Techniques for design synthesis
- Definition of functional and physical architectures
- Methods for system analysis and control
- Importance of managing the system configuration
- Specialty engineering (e.g., maintainability, reliability, EMI/EMC, manufacturability, etc.)
- System verification and validation
- Planning project technical activities
- Management and control of project development
- Project cost estimation, cost control (*i.e.*, earned value) and cost management
- Risk management
- Technical management

The detailed syllabi are appended to this proposal.

Completion Requirements

As required by the College of Engineering, Technology and Computer Science in accordance with the requirements of the Purdue University Graduate School:

1. The total number of credit hours required is 12.
2. All courses must be taken for a letter grade.
3. The curriculum for the 12-credit hour certificate:

Course	Course Name	Credit
SE 510	Systems Engineering	3
SE 520	Engineering Economics	3
SE 530	Engineering Management	3
SE 540	System Architecture	3
Total		12

4. GPA requirements: Each SE course to be applied toward the certificate must be completed with a grade of "B" or better.
5. No credits from undergraduate-level courses may be used toward the certificate.
6. Some students will be taking only one course at a time; others may need to sit out for a semester, so the maximum time allowed for completion of this 12-hour certificate is three years, unless waived by the Department of Engineering.
7. Students already enrolled in the M.S.E. program are not eligible for the certificate. Exceptions will be considered if a student enrolled for the M.S.E. must leave that program prematurely without completing the full curriculum. If the requirements for the certificate have been fulfilled, the student may petition the Department of Engineering Graduate Committee to request the certificate.
8. Students who initially enroll in the certificate program may apply for the M.S.E. near completion of the certificate requirements or after the certificate has been granted. Courses completed with a grade of B or better would be applied for credit toward the master's degree up to a maximum of 12 hours.
9. Students may take a maximum of six credit hours prior to admission to the certificate program that may be counted toward completion of the certificate. (Students can receive additional credit if the courses were taken prior to approval of the certificate program.)
10. If approved by the Department of Engineering Graduate Committee, a maximum of three graduate-level transfer credits may be applied to the requirements for the certificate.

IV. Admission Requirements

Admission to the certificate program requires that students meet the requirements of the Purdue University Graduate School.

1. IPFW Engineering Graduate School Admission Requirements
 - a. Bachelors degree in an engineering discipline
 - b. Graduates with Bachelor of Science in the physical sciences, computer science, mathematics or technology may also be considered for admission.
2. An undergraduate cumulative grade point average of 3.0 on a 4.0 grading scale or equivalent
3. Mastery of the English language as evidenced by
 - a. *TOEFL for Non-Native English Speakers:*
Minimum Paper-Based Test (PBT) Score Required: 550
Minimum Computer-Based Test (CBT) Score Required: 213
Minimum Internet-Based Test (IBT) Overall Score Required: 77
With the following minimum section requirements:
Reading: 19
Listening: 14
Speaking: 18
Writing: 18
 - or
 - b. *IELTS (Academic Module):*
An alternative to the TOEFL, band scores of 6.5 or higher will be accepted

V. List the major student outcomes (or set of performance based standards) for the proposed certificate.

To summarize the outcomes listed in the appended syllabi, students who complete the required courses should be able to demonstrate the following knowledge:

- a. A robust approach to the design, development, verification and validation of interdisciplinary products or systems.
- b. Techniques to ensure that their project teams will work to a single, integrated set of requirements and systems engineering processes.
- c. Methods for developing products within customer cost and schedule constraints.
- d. Practices for dealing with increased product complexity, shortened time-to-market, technology obsolescence, commercial technology insertion, system development and verification of software and management of systems-of-systems integration.

VI. Explain how student learning outcomes will be assessed (student portfolios, graduate follow up, employer survey, standardized test, etc.) and describe the structure/process for reviewing assessment findings for the purpose of ensuring continuous improvement of the certificate.

To summarize the grading strategies outlined in the appended syllabi, learning outcomes will be assessed through homework, exams and projects. The set of learning outcomes for the certificate program will be assessed through student evaluations, graduate follow-up surveys and review by industry. The resulting feedback will be used to revise the curriculum as appropriate ensuring the continued relevance of the program. In addition, the aggregate data will be reviewed annually by the program faculty and industrial advisory committee.

VII. Describe student population to be served.

The systems engineering graduate certificate is open to candidates who meet the admissions requirements, but it is most likely to serve:

- Those with advanced degrees in related technological or scientific disciplines or students currently enrolled in related technological or scientific graduate programs seeking to augment their studies in the theory and practice of systems engineering.
- Working engineers and technologists with bachelor's degrees who want training in systems engineering, but are not prepared to commit to a master's degree program

VIII. How does this certificate complement the campus or departmental mission?

IPFW and the Department of Engineering are committed not only to contributing to the economic well-being of Northeast Indiana, but also to preparing students to be active and responsible members of a global society and workplace. Increasingly that means post-baccalaureate study that includes enhanced understanding of the context of their professional engineering activities. This program fulfills this mission and scope in the following ways:

- It focuses on engineering knowledge and skills needed in local industry that are not currently available elsewhere in Northeast Indiana.
- It allows students to begin graduate level study with a specific goal without requiring the commitment of time and financial resources necessary to pursue master's level study. Yet it provides the option to continue for a master's and includes much of the foundational coursework required for M.S.E.

IX. Describe any relationship to existing programs on the campus or within the university.

Currently, IPFW has a limited number of graduate level certificate programs, although others are in the approval process. Those already approved address specialized fields like organizational leadership and supervision, applied statistics, English education, and nursing administration. The proposed graduate certificate emphasizes understanding and applying an end-to-end systems approach to scoping, designing, building, integrating, verifying and validating complex and interdisciplinary products using a framework which is consistent with government and industry standards. It is designed for students who have completed their bachelor's degree and are seeking additional education and graduate students from other fields of study. The courses in the graduate certificate are part of the core of the systems engineering focus of the M.S.E. program. While the certificate can stand alone, coursework taken under this certificate designation can be applied directly to the M.S.E.

This certificate supports Northeast Indiana workforce development needs. Industrial support for systems engineering is evident in the local support for this program by Raytheon, ITT Industries, General Dynamics, Undersea Sensor Systems, International Truck and Engine, and Northrop Grumman who joined with the Lilly Foundation to create an endowed faculty position and a Center of Excellence to initiate the systems engineering program. Additionally, in September, the Indiana Office of Energy and Defense Development released a draft "business plan" for increasing defense electronics business in the state of Indiana. This plan notes a need to "dramatically expand" systems engineering programs across the state and further observes that "this is a very high priority." The proposed graduate-level certificate is a key element in meeting this critical state need.

X. List and indicate the resources required to implement the proposed program. Indicate sources (e.g., reallocations or any new resources such as personnel, library holdings, equipment, etc.).

The proposed graduate level certificate can be initiated with our current faculty. Library materials will be covered by those available to support the current systems engineering course work. Publicity costs also will be covered in tandem with the master's degree. As stated in the M.S.E. proposal, additional faculty lines may be needed as enrollment in the master's and certificate programs grow.

XI. Describe any innovative features of the program (e.g., involvement with local or regional agencies, or offices, cooperative efforts with other institutions, etc.).

The innovative feature of this program is the curriculum itself. It combines theory and practice that is currently not offered elsewhere in Northern Indiana. It is immediately applicable to local industrial practices and also provides a foundation for more specialized study for those interested in advanced work at the master's degree level.

XII. Administration

A. Graduate School Administration Role

As specified, by the Graduate School, the following administrative processes will be followed:

1. The admission process shall generally parallel that for students seeking a graduate engineering degree at IPFW.
2. The Office of the Registrar will establish a special admission status for students enrolled in the certificate program.
3. When a student completes requirements for the certificate, the graduate program in the Department of Engineering will notify the Graduate School, which will then notify the Office of the Registrar.
4. The certificate will be posted separately upon completion of the requirements and recorded in the following manner:

Graduate Certificate

Field of Study: Engineering

Specialization: Systems Engineering

Credits earned toward a certificate will be included in the computation of the overall GPA posted on the transcript.

5. The Office of the Registrar will arrange for preparation of the certificate.
6. The certificates will be awarded at the usual times set for graduation.
7. The Department of Engineering will submit an annual report to the Graduate Council containing the following information:
 - a. the number of students currently admitted to the certificate program
 - b. for each admitted student:
 - 1) date admitted
 - 2) whether or not the student is also currently admitted to a degree program at Purdue, and if so, which degree
 - 3) number of credits completed toward fulfillment of certificate requirements
 - c. number of certificates awarded annually.

B. Department of engineering Administration Role

1. At the end of each semester (including summer school), after the initial enrollment of the student in the certificate program, the student's record will be updated by the Department of Engineering to reflect courses completed toward certificate requirements. If the requirements are completed by the end of three years, then the student will be informed as will the Graduate School. If the student is not enrolled at IPFW at the time of completion, the student will be

enrolled "for degree only" and the student's mailing address for the certificate will be requested and sent along to the Graduate School which will forward it to the Office of the Registrar. If the requirements are not met by the end of four years, the student will be asked to verify any extenuating circumstances that may have caused the delay. If the circumstances are deemed to be credible, the student may be granted an extension of the initial time limit. However, if there are no extenuating circumstances or none that are deemed credible, then the student and the Graduate School will be informed of the student's dismissal from the Department of Engineering certificate program.

2. Upon notification by the Graduate School of the completion of the certificate requirements, the Office of the Registrar will provide the certificate to the student.

Appendix A Course Syllabi

SE510 Systems Engineering

Credits: 3

Systems Engineering (SE) is a structured approach to developing interdisciplinary and complex products. This course will introduce SE methodologies spanning the product development lifecycle from initial scope definition through delivery of the prototype or first production article. SE techniques are used to define and manage requirements, analyze and optimize product architectures, develop comprehensive designs, plan, supervise and carry out the system design and verification activities. SE also provides techniques for ensuring that system-level requirements (*i.e.*, reliability, maintainability, safety, manufacturability, etc.) are incorporated into the final product. Spanning all these activities are a set of SE analysis and control functions that continuously assess and manage the product scope, quality, configuration, interfaces and performance.

Prerequisites: (If none, please explain reasons for absence)

Senior or Graduate standing

Course Outline:

Classes are 2.5 hours long and will be held once a week

Day	Topic
1	Systems Engineering Overview
2	Systems engineering Processes and Standards
3	Concept Development and System Scope
4	Requirements and Specifications
5	Functional Analysis and Allocation
6	System Trades / Exam 1
8	System Trades
9	Design Synthesis and System Architecture
10	System Analysis and Control
11	Configuration Management
12	Specialty Engineering 1
13	Verification and Validation 1/ Exam 2
14	Verification and Validation 2 and Planning
15	Putting it together: the B-2 Case Study
16	Final Exam

Method of Evaluation or Assessment:

30% Homework
20% First Exam
20% Second Exam
30 % Final Exam

Course Outcomes

A student who successfully completes the course will have demonstrated:

1. An understanding of Systems Engineering processes and standards.
(ABET codes: a, f, h, 1, 7,9)
2. Familiarity with the project and product lifecycle.
(ABET codes: a, e, f, h, 1, 7, 9)
3. An ability to define scope with a work breakdown structure.
(ABET codes: c, e, g, k, 3, 4, 8)
4. The capability to write requirements and specifications.
(ABET codes: c, e, g, k, 3, 4, 8)
5. Techniques for performing functional analysis.
(ABET codes: b, c, e, k, 2, 3, 4, 8)
6. The ability to develop and perform system trades.
(ABET codes: b, c, e, k, 2, 3, 4)
7. The ability to construct and analyze a system architecture.
(ABET codes: b, c, e, g, k, 2, 3, 4, 8)
8. Familiarity with configuration management processes.
(ABET codes: a, c, k, 1, 3, 4)
9. An understanding about how to design systems that are easy to manufacture and maintain as well as safe.
(ABET codes: a, c, e,1, 3, 4, 9)
10. Knowledge of techniques for verifying a design and validating a product.
(ABET codes: c, f, k, 3, 4, 7, 8)
11. An understanding of the types of plans needed in engineering a complex system.
(ABET codes: c, e, g, 3, 4, 8, 9)

ABET Classification: Engineering Science: 50%
 Engineering Design: 50%

Reading List:

Readings will be assigned from:

1. *Systems Engineering Fundamentals*, Supplementary Text, Prepared by the Defense Acquisition University Press Fort Belvoir, VA 22060-5565, January 2001
2. *INCOSE Systems Engineering Handbook V2a*, June 1, 2004
3. *CMMI® for Development, Version 1.2*, CMU/SEI-2006-TR-008, Carnegie Mellon, Software Engineering Institute, CMMI Product Team, August 2006.
4. *Work Breakdown Structures For Defense Materiel Items*, Mil-Std-881A, OSUD (AT&L), Washington, DC, 20 July 2005.
5. *Technical Measurement, Technical Report V1.0*, INCOSE-TP-2003-020-01, prepared by Garry Roedler, Cheryl Jones, Dec. 27, 2005.
6. *Defense and Program-Unique Specifications Format And Content*, MIL-STD-961E, Department Of Defense, August 1, 2003.
7. *DoD Architecture Framework, Version 1.0, Volume II: Product Descriptions*, DoD Architecture Framework Working Group 9, February 2004
8. *B-2 Systems Engineering Case Study*, John M. Griffin, James Kinnu and John, M. Colombi, Center for Systems Engineering, AFIT, Wright Patterson AFB, OG

SE520 Engineering Economics

Credits: 3

This course will provide an overview of financial accounting and economic principles employed by engineers involved in product and system development. It is intended to familiarize engineers with methods in project accounting, budgeting, cost estimation, financial management, design optimization and economics.

Prerequisites: (If none, please explain reasons for absence)

Senior or Graduate standing

Course Outline:

Day	Topic
1	Course Intro and Objectives / Intro to Project Scope
2	WBS and Scope / Intro to Cost Accounting
3	Cost Allocation and Cost Pools
4	Project Accounting Structures and Reporting
5	Intro to Cost Estimation
6	Cost Estimation: Basis of Estimates
7	Integrating Project Schedule to Generate Budgets
8	Introduction to Risk Analysis
9	Assessing Risk
10	Quantifying Cost Risk and Risk Management
11	Decision Making
12	Trade Studies and Exam Review
13	1st Exam
14	Cost as an Independent Variable
15	Design to Cost
16	Cost Performance Systems - Introduction to EVMS
17	Earned Value Analysis
18	Estimating Cost at Completion (EAC)
19	Constructing a Project EVMS
20	Scoring Earned Value
21	Nunn-McCurdy and Re-baselining Budgets
22	Time-Value of Money
23	Interest and Rates of Return
24	Investment Strategies and Assessment
25	2nd Exam
26	Investment Strategies and Assessment 2
27	IRAD and Capital Budgeting
28	Corporate Financial Statements
29	Corporate Financial Statements 2 and Review
30	Final Exam

Method of Evaluation or Assessment:

30% Homework

20% First Exam

20% Second Exam

30

% Final Exam

Course Outcomes

A student who successfully completes the course will have demonstrated:

1. Use of a work breakdown structure (WBS) to document project scope.
(ABET codes: c, d, e, g, k, 2, 4, 5, 6, 7)
2. The ability to read and understand project financial reports.
(ABET codes: d, k, 4, 5)
3. An understanding of techniques used to estimate project costs.
(ABET codes: c, d, k, 2, 4, 5, 8)
4. Knowledge of criteria for developing basis of estimates for project costing.
(ABET codes: c, d, f, k, 2, 4, 5, 7, 8)
5. Techniques for quantifying risk.
(ABET codes: c, d, k, 2, 4, 5, 8)
6. Use of risk in determining cost reserves.
(ABET codes: c, d, f, k, 2, 4, 5, 7, 8)
7. Use cost as a criteria in making design and development decisions.
(ABET codes: b, c, d, e, k, 1, 2, 3, 4, 5, 7, 8)
8. Familiarity with EVMS metrics.
(ABET codes: c, d, k, 2, 4, 5, 8)
9. An understanding of the time value of money.
(ABET codes: c, d, k, 5, 8)
10. An ability to read and understand corporate financial reports.
(ABET codes: e, h)

ABET Classification: Engineering Science: 80%
Engineering Design: 20%

Reading List:

Modern Cost Management, 2nd Ed., 2000 (In paperback)
Jae K. Shin, Joel G. Siegel, Ph.D.
Barron's Educational Series, Inc.

Engineering Economics, Thirteenth Edition,
William Sullivan, Elin Wicks, James Lukhoj
ISBN 0-13-148649-7
Pearson Education, Inc., 2006

Mil-Std-881- HDBK, Work Breakdown Structures, DoD, 1998.(Available on-line)

Risk Management Guide for DoD Acquisition, sixth edition (Version 1.0), Department of Defense
August 2006.(Available on-line)

Standard for Earned Value Management Systems Intent Guide, National Defense Industrial
Association (NDIA), Program Management Systems Committee (PMSC), ANSI/EIA-748-A, Jan
2005. (Available on-line)

or

Earned Value Management Application Guide United States Department of Energy, Version 1.6,
January 1, 2005. (Available on-line)

SE530 Systems Engineering Management

Credits: 3

The systems engineering (SE) management team is responsible for planning and managing all systems engineering activities that are required to successfully develop complex products and systems. They are in charge of ensuring that all system elements are compatible, available on-schedule and on-budget, work together seamlessly, and satisfy customer requirements.

This course will address the role and activities of the systems engineering team in managing and coordinating product development. Topics will include systems engineering planning, management of scope, risk and cost, configuration, interfaces and human resources, project control, reviews, performance measures, standards and documentation.

Prerequisites: (If none, please explain reasons for absence)

1. Senior or graduate standing in either an engineering or science degree program, and
2. SE 510 Systems Engineering or Consent of the Instructor

Course Outline:

Class	Topic
1	Overview of Systems Engineering
2	Overview: SE Management and SE-CMM
3	Systems Engineering Plans (SEPs)
4	Concept Development and Scope
5	System Architecture and Design
6	Functional Analysis and Requirement Process
7	Specifications and Configuration Control
8	Make/Buy Decisions and Subcontracting
9	Specialty Engineering 1
10	Specialty Engineering 2
11	System Synthesis
12	Risk Management 1
13	Risk Management 2
14	Integration, Test and Evaluation / Exam Review
15	Exam #1
16	Manufacturing, Producibility, and Integrated Logistics
17	Engineering Change Control
18	Verification, Validation and Qualification
19	Project Organization
20	Human Resources
21	The Integrated Master Plan / Integrated Schedule
22	Systems engineering Planning/ Exam Review
23	Exam #2
24	SE Balance Functions
25	SE Documentation / Data Management
26	Engineering Reviews
27	Cost Estimation
28	CAIV / DTC
29	Earned Value 1
30	Earned Value 2 / Exam Review
31	Final Exam

Method of Evaluation or Assessment:

- 30% Homework
- 20% First Exam
- 20% Second Exam
- 30 % Final Exam

Course Outcomes

A student who successfully completes the course will have demonstrated:

1. An understanding of role of the systems engineering team in product development
(ABET codes: 2, 4, 5, 7, 8, 9, a, d, g, j, k)
2. Knowledge of systems engineering practice and its integration into the product development lifecycle.
(ABET codes: 1, 2, 4, 5, 7, 8, 9, a, d, e, i, j, k)
3. An understanding of systems engineering balance functions that span the project lifecycle: management of scope, requirements, interfaces, configuration, risk, cost and data.
(ABET codes: 1, 2, 4, 5, 7, 8, 9, a, c, d, i, j, k)
4. Techniques for planning the technical effort
(ABET codes: 1, 2, 4, 7, 8, a, c, d, f, g, k)
5. The use of program phased gates and reviews to verify and validate progress
(ABET codes: 4, 5, 7, 8, a, c, d, f, g, k)
6. Techniques for quantifying and reducing development risk.
(ABET codes: 2, 4, 5, 8, c, d, e, k)
7. Ability to assess the advantages and challenges associated with the method for integrating engineering functions into companies and projects organizations
(ABET codes: 5, d)
8. An understanding of techniques used to estimate project costs.
(ABET codes: 2, 3, 4, 5, 7, c, d, f, k)
9. Techniques for managing cost during product development
(ABET codes: 2, 3, 5, 7, 8, b, d, e, f, k)

ABET Classification: Engineering Science: 60%
 Engineering Design: 40%

Reading List:

Readings will also be assigned from

Systems Engineering and Analysis (4th Edition), by Benjamin S. Blanchard, Wolter J. Fabrycky, Prentice-Hall International Series in Industrial and Systems, 2006.

Systems Engineering Plan (SEP) Preparation Guide, Ver.1.0, OUSD(AT&L) Defense Systems/Systems Engineering/Enterprise Development, November 15, 2005

Available on-line at: www.acq.osd.mil/se/publications/pig/sep_prepguide_v1.pdf

A Systems Engineering Capability Maturity Version 1.1, R. Bates et al., Software Engineering Institute, SECMM-95-01, CMU/SEI-95-MM-003, November 1995.

Available at: <http://www.sei.cmu.edu/pub/documents/95.reports/pdf/mm003.95.pdf>

Systems Engineering Fundamentals, Supplementary Text, Defense Acquisition University Press Fort Belvoir, VA, January 2001.

Available at <http://www.dau.mil/pubs/pdf/SEFGuide%2001-01.pdf>

Work Breakdown Structures For Defense Materiel Items, Mil-Std-881A, OSUD (AT&L), Washington, DC, 20 July 2005.

Available at <https://acc.dau.mil/GetAttachment.aspx?id=54787&pname=file&aid=18712>

DSMC Risk Management Guide for DoD Acquisition (Fourth Edition), DoD, Defense Systems Management College, Published By The Defense Acquisition University Press, Fort Belvoir, Virginia 22060-5565, February 2001.

Available at www.mitre.org/work/sepo/toolkits/risk/references/files/DSMC_RiskMgmt_Guide.pdf

Risk Management Guide for DoD Acquisition, Ver. 1.0, OUSD (AT&L) Systems and Software Engineering/Enterprise Development, DoD, August 2006.

Available at: <http://ax.losangeles.af.mil/axl/Risk%20Mgmt%20Guide%20for%20DOD%20Acq.pdf>

NDIA PMSC ANSI/EIA-748-A Standard for Earned Value Management Systems Intent Guide, National Defense Industrial Association (NDIA) Program Management Systems Committee (PMSC), January 2005.

Available at:

<http://oecm.energy.gov/admin/Portal/LinkClick.aspx?tabid=79&table=Announcements&field=ItemID&id=13&link=NDIAIntentGuide.pdf>

SE540 Systems Architecture
Credits: 3

Systems engineering best practices prescribe a set of methodologies for architecting and designing complex systems. This course will cover requirements analysis, functional analysis and allocation, and synthesis and their interaction with systems analysis and control functions including system trades, management of risk, configuration, interfaces and data, and development of performance measures. The lectures will be complemented by a class design project to architect a complex system leading to development of a functional and physical architecture and associated functional and allocated baselines.

Level of the Course:

Anticipated Percentage of Undergraduate Student Enrollment: 10%

Anticipated Percentage of Graduate Student Enrollment: 90%

Prerequisites: (If none, please explain reasons for absence)

SE510 Systems Engineering or equivalent

Course Outline:

Classes are 2.5 hours long and will be held once a week. The first half of each class will be theory and second half will be project engineering

Day	Topic
1	The Art of Architecting / Project Introduction
2	Heuristics and Systems Engineering / Project Scope
3	Managing Uncertainties / Project Plans and Requirements
4	Manufacturing / Requirement Analysis
5	Social Systems / Interface Definitions
6	Software and Info. Technology / Functional Analysis 1
8	Collaborative Systems / Functional Analysis and Allocation 2
9	Mid Term Exam / Risk ID and Assessment
10	System Representation and Models / Performance Measures
11	Design Progression / Trade Studies 1
12	Integrated Modeling / Trade Studies 1 / Functional Architecture
13	Architectural Frameworks / Project Synthesis
14	Decision Making in the Real world / Project Synthesis
15	The System Architect / Project Summation
16	Final Exam

Method of Evaluation or Assessment:

25% Homework

25% Class Project

20% MidTerm

30% Final Exam

Course Outcomes

A student who successfully completes the course will have demonstrated:

1. An advanced capability to generate a work breakdown structure that defines scope
(ABET codes: c, e, g, k, 3, 4, 5, 8)
2. A capability to work with stakeholders to identify, derive and allocate system requirements.
(ABET codes: c, e, g, k, 3, 4, 5, 8)
3. An ability to generate comprehensive Interface Control Documents (ICDs)
(ABET codes: b, c, e, g2, 3, 4, 5, 8)
4. The ability to apply functional analysis techniques to real world problems
(ABET codes: b, c, e, k, 2, 3, 4, 8)
5. An understanding of how to design and perform complex system trades.
(ABET codes: b, c, e, k, 2, 3, 4, 5)
6. The ability to construct both functional and physical architecture.
(ABET codes: b, c, e, g, k, 2, 3, 4, 8)
7. An understanding of how to incorporate specialty engineering into system architectures
(ABET codes: c, d, g, 2, 3, 4, 8)

ABET Classification: Engineering Science: 40%
 Engineering Design: 60%

Reading List:

Textbook

The Art of Systems Architecting, 2nd Ed. by Mark W. Maier and Eberhardt Rechtin, CRC Press, 2000.

Readings will also be assigned from:

1. *Systems Engineering Fundamentals*, Supplementary Text, Prepared by the Defense Acquisition University Press Fort Belvoir, VA 22060-5565, January 2001
2. *INCOSE Systems Engineering Handbook V2a*, June 1, 2004
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