Course Objective:
The objective of this class is to understand and practice the use of frameworks, processes, tools and software applications that are associated with describing and modeling product and enterprise system architecture. The course references government and industrial standards, which guide systems engineering decision-making and design. The course lectures and project contrast important architectural frameworks for the design and improvement of product and enterprise systems; these may include the DoDAF, TOGAF, and Zachman system architecture frameworks. The course project includes analysis of architectural alternatives to meet system Functional Requirements and the ability to provide system assurance in an environment that takes people, process, and technology goals into account. Modeling tools such as UML/SysML and the use of model-driven architectures will be examined. Design verification and validation methods will be discussed. Methods of identifying and mitigating risk will be explored.

This course emphasizes a systems engineering perspective and is a core requirement for the Masters of Science in Engineering, Systems Engineering specialization.

Credits: 3

Preparation for Course: SE 51000 or equivalent

Level: Dual Level, Undergraduate or Graduate
Course Outcomes:

1. Ability to apply the terminology pertaining to architectural descriptions to design (and improve) systems

2. The ability to use ANSI/IEEE1471-2000 and ISO/IEC/IEEE 42010:2011 architectural descriptions and gain an understanding of the evolution of these standards

3. Knowledge of your possible role(s) and responsibilities as a system architect

4. Ability to apply architecture frameworks to design a product or enterprise as a system

5. Ability to critically evaluate the pros and cons of an architecture framework (facilitated by literature survey).

6. Learn how to design and develop a product that is producible

7. Ability to apply the use of an architectural framework in product development

Evaluation:

15% Homework – Write ups and Readings (6 Sets)
15% Homework – Presentations / Class Participation and Discussion
25% Final Exam
20% Final Project Write-Up and Analysis
10% Final Project Presentation
15% During-term Project Presentations and Short Write-Ups (2 Packages)

Homework:

For several of the homework assignments, you are asked to prepare a short presentation for class, which will then be followed by Q&A discussion.

In order to gain an understanding of how to apply and use the Architecture Frameworks that will be used during the class, the following homework assignments will be discussed in class (and you may be called on to present your short presentation):

HW3 – CubeSat Architecture Description with DoDAF
HW4 – CubeSat Architecture Description with TOGAF and contrast with DoDAF
HW6 – 3D Printing and SysML

Each of the above homework’s will apply to CubeSAT requirements.

Website:
http://www.nasa.gov/directorates/heo/home/CubeSats_initiative
CubeSAT Spec:
http://www.nasa.gov/pdf/627972main_LSP-REQ-317_01A.pdf
Project: The class project may be an individual or team of 2 people assignment, which is meant for you to apply the use of Architecture Framework in the design of a product (please see Prosthetic Hand Project Description and CubeSAT descriptions in this document) of your selection. For major dates and milestones, please see the attached SE 54000 Class Schedule. The approach of this course is that the homework assignments will give you a chance to practice the use of the system architecture frameworks and tools, while the Project will give you the chance to take the deep dive into product design and its relationship to system architecture.

We will have two intermediate “project packages” throughout the term that consist of a short presentation, as well as a write-up description that accompanies your presentation. Your written description is not limited to what you present at the class meeting. Instead, it should cover everything that you have done to that date and should address the key questions described in the Homework and Project Write-Up Description Column of the SE 54000 Class Schedule.

Readings: Readings will be assigned weekly and posted on the Blackboard web site under the “Library/References” folder or distributed electronically.

Project Sets – Course project development will be guided by project-set assignments; each week a project set will be exchanged between students. Each student will verify whether the project set is complete or incomplete. If complete, “1” point will be assigned. If incomplete, you will have the opportunity to re-submit the set on the following week to receive full “1” point, if complete. If incomplete, a Project Set receives “0” points. Project sets will be reviewed in class from 8:25 to 8:45 pm, as required.

For all electronically submitted documents, please include your name and a description of the assignment in the file name.

Assignment Due Date. All Assignments are due by 2:00 pm on the day of the class meeting, by email. All Late assignments will receive zero credit. For every assignment, please bring a hard copy to the class and send an electronic to the instructor’s campus email.

For Project Sets, please bring a hard copy of your project set to class to give to your colleagues to review and submit an electronic copy by email to the instructor at their campus email.

For Homework, please submit only an electronic copy by email to the instructor at their campus email.
For your mid-term and Final presentation and paper, please submit an electronic copy of your paper and presentation to the instructor and bring to class a hard copy of your presentation (full size format) and a hard copy of your write-up paper. Bring your computer with your presentation file and be prepared to plug your computer into the AV system for your presentation.

A Note about technical writing:
1. Do not use personal pronouns: I, we, he, she, they, it and also you, me, my, mine, etc..

2. When you have to use the word “this”. Please use the form this <noun i.e., a thing>. For example, correct usage: This information is really good. Incorrect usage: This is really good… as the reader does not necessarily know what this refers to, particularly in a technical document.

3. Use of Acronyms: When introducing an acronym state the acronym with initial capital letters, for example, Integrated Logistical Support (ILS) and the put the initial caps in parentheses after the acronym that you are introducing.

A Note about assignments:

1. Please number (paginate all documents that are turned in).

2. Please put your name on all of your work.

3. For presentations, please use at least 18 point type.
Partial List of References


Quality Function Deployment, a White Paper from the Creative Industries Research Institute, Aut University, 2007.


Patterns: Service-Oriented Architecture and Web Services, by Mark Endrei et. al., IBM Redbooks, IBM, 352 pgs., April 2004


Possible Project Topics:

1. SE 54000 Project description – Prosthetic Hand

Develop a design for a prosthetic hand/digit to be produced via 3D printing.

Upon completion of the project you will have the opportunity to use a 3D printer in the SE lab to print your design.

Current State

Patients with missing limbs range from children with birth defects to traumatic amputees, and amputations due to circulatory issues. Roughly 1 in every 200 people in the US have some sort of missing limb. Patients are faced with several potential solutions ranging from surgery to expensive prostheses or living with the disability. Obviously, the latter situation is not ideal for ongoing health or for society. Costs for high tech prosthetic limbs can range up to 100k US$. Also the high tech devices may not work well in some environments and activities of daily living.

The advent of 3D printing combined with creative minds has opened a new possibility for some of these patients. Enterprising patients, parents, caregivers, and engineers have designed a number of prosthetic hands for children. A website, www.enablethefuture.org, has been created to collect designs, facilitate access, and generally promote the use of these ideas. Each design is different with potential improvements that could be made to facilitate patient use, manufacturability, and durability.

References:

http://www.touchbionics.com

http://www.bebionic.com

http://www.enablethefuture.org

2. Design a CubeSAT (microsatellite)

CubeSAT are a miniaturized satellite built by Universities for space research that that is 10.0 cm (4 in.) cube with a mass that is typically one kilogram, and is built from commercial off-the-shelf electronics components. Dr. Jordi Puig-Suari at California Polytechnic State University (Cal Poly) and Dr. Robert Twiggs at Stanford University developed the CubeSAT concept and specifications.

References:

http://www.nasa.gov/directorates/heo/home/CubeSats_initiative
## Presentation scoring rubric

<table>
<thead>
<tr>
<th>Element</th>
<th>Score = 2 points</th>
<th>Score = 4 points</th>
<th>Score = 6 points</th>
<th>Score = 8 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Presentation</strong> 30%</td>
<td>• No clearly-defined objective</td>
<td>• Objective is vague</td>
<td>• Objective is fairly clear and concise, but could use a little tweaking</td>
<td>• Objective is stated directly and clearly explained</td>
</tr>
<tr>
<td></td>
<td>• Presentation rambles</td>
<td>• Organization elements are present, but weak logical flow</td>
<td>• Presentation outline is clearly evident</td>
<td>• Organized—clear beginning, middle, and end with logical thought progression and elements relevant and well-integrated</td>
</tr>
<tr>
<td></td>
<td>• Lack of coherent arguments</td>
<td>• Arguments are not clear</td>
<td>• Main point is clear</td>
<td>• Objective is clear and well-integrated</td>
</tr>
<tr>
<td></td>
<td>• Ideas not integrated</td>
<td>• Objective is not clear</td>
<td>• Objective are articulated</td>
<td>• Collaboration of groups effort is seamless</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Team member ideas not well-integrated</td>
<td>• Group effort is seamless</td>
<td></td>
</tr>
<tr>
<td><strong>Background, Data, and Graphics 20%</strong></td>
<td>• No mention of sources</td>
<td>• Credit to sources not given</td>
<td>• Credit is given to others when due</td>
<td>• Credit given clearly when due</td>
</tr>
<tr>
<td></td>
<td>• No visual aids</td>
<td>• Ineffective use of visual aids</td>
<td>• Visual aids answers assignment query</td>
<td>• Visual aids are clear and concise</td>
</tr>
<tr>
<td></td>
<td>• Supported printed materials not provided</td>
<td>• Supporting printed materials provided to professor</td>
<td>• Supporting printed materials provided to professor</td>
<td>• Supporting printed materials provided to professor at presentation time</td>
</tr>
<tr>
<td><strong>Analysis and Conclusions 30%</strong></td>
<td>• Presentation does not address assigned deliverable</td>
<td>• Link to assignment is vague</td>
<td>• Clear link to assignment</td>
<td>• Presentation thoroughly summarizes deliverable</td>
</tr>
<tr>
<td></td>
<td>• No relevance to outstanding issues</td>
<td>• Relevance of some material is unclear</td>
<td>• Awareness of differing views and implications considered</td>
<td>• Alternative views are considered</td>
</tr>
<tr>
<td></td>
<td>• Alternate views ignored</td>
<td>• Alternate views dismissed</td>
<td>• Conclusions are inferred</td>
<td>• Conclusions are supported by data</td>
</tr>
<tr>
<td></td>
<td>• Lacking in personal reflection</td>
<td>• Conclusions are vague and unsupportable</td>
<td>• Analysis ties to assignment</td>
<td>• Analysis addresses assignment</td>
</tr>
<tr>
<td></td>
<td>• Lacks stance on findings</td>
<td>• Insights and findings not shared</td>
<td>• Student take firm, articulate stand</td>
<td>• Key insights are shared</td>
</tr>
<tr>
<td><strong>Style 20%</strong></td>
<td>• Many errors</td>
<td>• Few errors</td>
<td>• Very few errors</td>
<td>• Presentation is seamless and fits allocated time</td>
</tr>
<tr>
<td></td>
<td>• Too long/short</td>
<td>• Slightly too long/short</td>
<td>• Proper length</td>
<td>• Well-rehearsed—model of clarity</td>
</tr>
<tr>
<td></td>
<td>• Not rehearsed</td>
<td>• Semi-rehearsed</td>
<td>• Well-rehearsed</td>
<td>• No technical difficulties</td>
</tr>
<tr>
<td></td>
<td>• Plagued with technical difficulties</td>
<td>• Several technical difficulties</td>
<td>• Very minor tech difficulties</td>
<td>• Polished and easy to follow</td>
</tr>
<tr>
<td></td>
<td>• No thought put into presentation format</td>
<td>• Presentation seems rushed or unrefined</td>
<td>• Well-edited</td>
<td>• A joy to watch—humor, personal touches, clever</td>
</tr>
<tr>
<td></td>
<td>• Lacks excitement</td>
<td>• Information presented with limited flair</td>
<td>• Presentation keeps class and professor's interest</td>
<td></td>
</tr>
</tbody>
</table>
**Student Conduct:**
The purpose of these sections is to ensure compliance with IPFW policies and procedures, to minimize disruptions to your classmates and ensure the integrity of the classroom experience.

**A. Cellphone/Blackberry**
*Cell phones should be set to either vibrate or silent*
Do not answer a cell phone in the classroom – If you must answer it, please answer it in the hall.

**B. Be on time:** A pattern of tardiness will merit discussion.

**C. Food/Drink**
Bottled water is acceptable
No food is allowed in the classroom

**D. Smoking**
Smoking is not allowed in IPFW buildings

**E. Missing an Exam or Late Homework**
You must contact me prior to missing an exam so that alternative arrangements can be made. Please let me know about planned absence as soon as you know that there will be an issue. This will help facilitate a mutually agreeable solution. Contacting me after the fact may result in your not being given an opportunity to retake an exam or receive homework credit.

**F. Missing a Class**
Missing an occasional class for professional reasons is allowable. However, you should contact me as soon as you know that you will be unable to attend the class so that alternative arrangements can be made to provide you with access to the class material and make arrangements for assignments.

**G. Academic Integrity**
Cheating and plagiarism will not be tolerated and consequences will be severe. In the absence of instructions to the contrary, students should assume that homework should be done alone and is not designed to be a group exercise. The university policy on academic honesty and rights and responsibilities is stated in the IPFW Graduate Bulletin.

**H. Disabilities**
If you have a disability and need assistance, special arrangements can be made to accommodate most needs. Contact the Director of Services for Students with Disabilities (Walb Union, Room 113, 260 481-6658) as soon as possible to work out the details. Once the Director has provided you with a letter attesting to your needs for modification, bring the letter to me. For more information, please visit the web site at [http://new.ipfw.edu/disabilities/](http://new.ipfw.edu/disabilities/); a text-only version is available at [http://new.ipfw.edu/offices/disabilities/text-version/](http://new.ipfw.edu/offices/disabilities/text-version/).

**I. Diversity and nondiscrimination**
IPFW is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the university seeks to develop and nurture diversity. The university believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. IPFW prohibits discrimination against any member of the university community on the basis of race, religion, color, sex, age, national origin or ancestry, marital status, parental status, sexual orientation, disability, or status as a disabled or Vietnam-era veteran.

**J. Military Service**
If you are a student in the military with the potential of being called to military service and/or training during the course of the semester, you are encouraged to contact both me and your advisor immediately.

**K. Proprietary Information**
Do not bring proprietary or company-sensitive information into the classroom. If you have any questions about the proprietary nature of the information you might use in your homework, please talk to your supervisor or the office responsible for releasing data. Any issues should be directed to my attention.

**L. Classified Data**
Do not discuss reference or hint at classified programs or data!