Course Description

Design is a crucial activity in the creation of an information system. It is challenging because of competing goals from multiple stakeholders, and the complexity of issues that can arise. In this course, we focus on design processes resulting in system requirements, as well as high-level architectural design of an information system. A design has to deliver desired functionalities and also meet non-functional qualities such as performance, cost, usability, timeliness, security, privacy, reliability, flexibility, maintainability, and so forth. Increasingly, system design is focused not only on a single isolated system, but on portfolios or families of systems, with more attention to interoperability, sharing, reuse, and evolution.

This course focuses on the design of networked information systems in the face of multiple competing or synergistic goals from many stakeholders. Examples will be taken from settings in e-health, e-learning, e-government, etc. A number of design approaches will be examined, with an emphasis on systematic, model-based approaches. The emphasis of the course is to help students gain an appreciation of the strengths and limitations of various techniques, and of the concept of design itself. These concepts of design are placed within the larger context of contemporary information systems development and software engineering. The significance of design representations (models and notations), methods and tools, and reusable design knowledge will be discussed. Students will work on projects to apply selected design methods and techniques.

Goals and Objectives

The overarching goal of this course is to gain a broad understanding of the concepts, issues, and techniques of system requirements and architectural design, in the context of information systems development, and to practice selected techniques through course projects.

Students having completed this course should be capable of:

- Understanding and articulating the role of stakeholder involvement, interdisciplinary collaboration and specific techniques of requirements elicitation in the requirements discovery, systems analysis and design process (as demonstrated in class discussions and assignments 1 and 3),
- playing a proactive role in the discovery, documentation and validation of system requirements in a variety of contexts (as demonstrated in assignments 1 and 2),
- collaborating effectively in teams working on realistic requirements and system design problems (as demonstrated in assignments 1 and 2),
determining the scope of a design problem and articulating system context and boundary (as demonstrated in assignment 1),

applying and evaluating techniques for eliciting, specifying, and communicating system requirements including goals, scenarios, and qualities to a wide range of stakeholders (as demonstrated in assignments 1 and 3),

applying, evaluating, and discussing techniques and models for creating, documenting, communicating, and evaluating architectural designs based on key system requirements (as demonstrated in assignment 2 and class presentations),

identifying, describing, assessing, and applying basic design patterns for software architecture (as demonstrated in assignments 2 and 3), and

systematically identifying, analyzing, explaining, synthesizing, and critiquing concepts, methods, techniques, and problems in the areas of system requirements and architectural design (as demonstrated throughout the course, but particularly in assignments 2 and 3).

Class Format
The class will meet for up to 3 hours each week. Each class will normally consist of a lecture, a team activity or guest conversation period, and a discussion period. The lecture portion of the class will introduce the key concepts and may cover material that is not available in published literature. There will normally be a 10-15 minute break after the lecture. This will often be followed by a team-based activity. The last section of the class will involve discussion of the team-based activity and the readings using questions from class members as a starting point, and sometimes an additional (shorter) lecture. On their own time, students must complete weekly course readings, complete written assignments alone and in teams, present results from teamwork in class, and maintain a blog. Active class participation is built into the course and considered an essential enabler of the learning experience.

Prerequisites
IS&D concentration or INF1003 or permission of instructor. INF1341 is strongly recommended.

Course Materials

Textbooks/Readings
This course does not have a textbook, but students wishing to have access to a textbook might consider the following books. Selected readings from these books are available on Blackboard. For requirements:


- Robertson, Suzanne, and James Robertson (2013) Mastering the Requirements Process—3rd ed., Addison-Wesley. (Referred to as RR in course schedule). [Inforum: 3rd ed. 2-hr
reserve; 2nd ed. 2-day reserve]

The authors of the book are also the creators of the Volere template, which will be used in A1; the book is a very accessible and comprehensive treatment of the requirements process. Recommended.

- Pohl, Klaus (2010). Requirements Engineering: Fundamentals, Principles, and Techniques. Springer (Referred to as Pohl in the course schedule.)

A highly systematic and exhaustive treatment from an engineering perspective, with a lot of attention to detail and a comprehensive set of references. Useful as a handbook too.

For architectural design (and software architecture and design processes in general):

- The following book is most recommended as a pragmatic and accessible overview and guidance to software architecture. It is more practice-focused and accessible than the following listings. (Referred to as RW in the course schedule.)

- The Microsoft Application Architecture Guide, 2nd Edition provides an excellent resource to consult for the second stage of the project. It explains key concepts, guidelines, fundamentals and types of applications, all of which described in general ways that are valid beyond Microsoft technology. It is available online at https://msdn.microsoft.com/en-us/library/ff650706.aspx.

- The following book is recommended as a thorough and practical in-depth treatment of software architectures.
  (Note that the 2013 edition is substantially different from previous editions.)
  Referred to as BCK in the course schedule

- This and the following book provide an industry-oriented perspective on systems design.


For Object-Oriented Design (and UML), the following book provides a very comprehensive and practical, detailed coverage.

  (referred to as Larman in the course schedule)

For Enterprise Architecture (and a well-founded perspective on modelling and communication):

Website/Resources
“Course materials and resources aimed at helping students with assignments and key concepts will be made available online, through Blackboard (http://portal.utoronto.ca). Students are responsible for keeping up to date with these online resources, and are expected to log into Blackboard during the first week of class to enroll for email notices. Please be sure to check Blackboard periodically for new materials, announcements, updates and other important information.” When PowerPoint slides are used, they will be made available online within 1-2 days of lecture.

Evaluation
The major assignments are focused on a system requirements and design project done in teams of four. (Depending on class size, a few teams may consist of three members.) Each team will design a mobile information service, specifying the requirements for the service and then proposing a system architecture designed to address these requirements.

Additionally, each student will post a series of blog entries.

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<thead>
<tr>
<th>Assignments</th>
<th>Weight</th>
<th>Due</th>
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<tbody>
<tr>
<td>Assignment 1: System Design -</td>
<td>50%</td>
<td>Pitch [3% team]: One slide in PDF submitted on Blackboard by Jan 18</td>
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<tr>
<td>Service Definition and System</td>
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<td>5:00 pm. Stand-up pitch in class on Jan 19.</td>
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<tr>
<td>Requirements</td>
<td>(15%</td>
<td>Vision [5% team]: Jan 28</td>
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<td>individual, 35% team)</td>
<td>Individual requirements [15% individual]: Feb 9</td>
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<td></td>
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<td>Combined requirements [15% team]: Feb 26</td>
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<td></td>
<td>Presentation [12%]: Presentation in class in weeks 7 and 8.</td>
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<td>Slides are due by 5:00 pm on the day before the presentation.</td>
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<tr>
<td>Assignment 2: Architectural Design</td>
<td>35%</td>
<td>Design presentation [10% team]: Project presentation of highlights</td>
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<td></td>
<td>(team)</td>
<td>from Assignment 2 in weeks 11 and 12. Slides are due by 5:00 PM on</td>
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<td>the day before the presentation.</td>
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<tr>
<td>Assignment 3: Blog</td>
<td>15%</td>
<td>Final design - written report [25% team], due April 10.</td>
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<td></td>
<td>(individual)</td>
<td>Peer evaluation forms – individual, due April 10.</td>
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<td>You will reflect on the course concepts and the application of</td>
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<td>requirements and design methods throughout the course in a series</td>
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<td>of blog entries.</td>
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Peer assessment of contributions by team members through confidential self & peer evaluation forms is required for all team work and is considered part of the grade. In team assignments, grades for individual members may differ. For an excellent guide to teamwork, consider http://bokcenter.harvard.edu/working-groups.

In Assignment 1, each team will design a mobile information service, specifying the system requirements for the service. You will use scenario techniques together with goal-modeling techniques to arrive at system requirements. The key objectives of this assignment are to learn
about the strengths and limitations of different perspectives and techniques in helping design information systems, leading to system requirements; to reconcile and articulate requirements from these perspectives; and to arrive at a consensus on key requirements expressed in a clear and standards-based requirements structure that can serve as the basis for the subsequent assignment. The topic and project idea is up to each team; early in the term, you will present a short pitch to share the initial idea for the proposed system with the class.

The assignment will proceed in 5 stages, as illustrated above:

- **Pitch:** The pitch is a 2-minute stand-up presentation pitching the project idea to the class in week 2, supported by one slide. This ensures that you share information about the project early, are able to validate assumptions, and can revise the scope and goals as you receive feedback.

- **Vision:** The vision is a short document defining the scope and project more formally to communicate the project’s vision and document a common basis for the individual analysis of requirements, thus ensuring a minimum level of common ground and consistency between the individual draft requirements. In the vision, you will also declare which team members focus on goal models and which team members focus on scenario specifications. (Normally 2+2).

- **Individual requirements:** This is an individual written assignment completed and submitted independently by each team member. You will apply either goal- or scenario-oriented requirements modelling techniques to the project outlined in the vision to discover and document a set of solution-oriented requirements for the system under design.

- **Combined requirements:** This is the combined requirements specification document, informed by the different perspectives resulting from the individual draft requirements. The team will reconcile the individual requirements to arrive at a consistent, self-contained requirements specification that drives the design process in assignment 2.

- **Requirements presentation:** This is an in-class team presentation of 10 minutes discussing highlights of the combined requirements document.

The combined requirements document is your starting point for **assignment 2**. As illustrated below, you will develop, evaluate and present an architectural design of an information system offering the information service defined in the combined requirements document that resulted from the first assignment.
- **Design presentation**: This is an in-class team presentation of 15 minutes discussing highlights of the architectural design and key design decisions.

- **Final architectural design**: This is a comprehensive document describing the proposed architectural design of the system and demonstrating how it addresses the requirements specified in the first assignment.

**Assignment 3**: Individual blog
You will post a series of contributions to the class blog. Your contributions will (and should) vary in terms of length and topic, but keep your posts focused on the topic and brief (up to 300 words). You are free to add links to materials, tools, articles and so forth, but you must ensure that they relate clearly to the issues at hand and that you add comments and explanation of their relevance. Your blog post must be completed latest by noon the day before class meets in the week the blog is due.

The blogs will be used to help shape the discussion in each class, and you are encouraged to raise questions in your posts that you would like to see addressed in the class discussion. You are also highly encouraged to read your peer’s blogs and engage in discussions on the blog, and meaningful comments will be considered in the blog grade. The blogs will receive a grade at the end of the term. You can skip two posts, i.e. (the best) three entries will be evaluated.

**Blog post topics**
1. **Week 1 (!) – Introductions**: Shortly present your background (including areas of study & professional interests) and suggest a project idea for the group project. (The idea can be very specific, or more generally characterize an area of particular interest that you would like to consider for the project.)
2. **Week 5 – Architecture**: Find a published diagram describing an information systems’ architecture, post it and discuss it using the questions suggested in BCK chapter 1 as a starting point: “What structure or structures are shown? … What analysis does the architecture diagram support? Critique it: What questions do you have that the representation does not answer?”
3. **Week 7 - Goals and scenarios**: Discuss your experiences with the reconciliation of individual requirements into the combined requirements document. What differences in the resulting requirements did arise between goals and scenario techniques? Why?
4. **Week 9 – Architecturally significant requirements**: Considering the requirements defined for your team project, which might be particularly significant for the overall architecture of the system? Discuss ideas on how to shape the system’s architecture to ensure one specific requirement can be met.
5. **Week 12 - The last entry will be a summary of reflections**: on the system design experience at the end of the course. Discuss major challenges and obstacles, surprising
insights, learning experiences, or how you would like to engage in requirements and architecture practices professionally. (This last entry can be posted after class, until the Sunday following the last class.)

Guidelines for Assignments

All written assignments for this course must be submitted as one PDF file on Blackboard at the corresponding due date. - Blog entries must be posted in the normal manner as text, not as attachments to the post. Where no time is given, the assignments are due at 23:59.

The required format for written assignments is as follows:

- One file in PDF format (not MS Word or other formats). Where diagrams are used, ensure they are contained in high resolution in the PDF.
- Typed, 1.5 space, 11 point font, one-inch margins, page numbers in the upper or lower right hand corner.
- Align paragraphs in a standard way and avoid superfluous indentation.
- No cover page required, but be sure to include your names & student numbers on page 1.
- Use of footnotes/endnotes is permitted.
- Total word count must be indicated at the end of the essay.
- Page layout must be in correct orientation, i.e., pages with content in landscape orientation must be rotated so that the content is right-side up when viewed electronically.
- For large documents, define bookmarks for the start of each main section.
- Text in figures must be legible, with sufficiently high resolution.

Where self and peer evaluation forms are required, these are considered part of the assignment, are due at the same time as the assignment, and need to be submitted individually through Blackboard through the appropriate file upload!

Assignments that do not meet a minimum standard (in terms of legibility, formatting, and proofreading) will be returned for re-submission, with late penalties in full effect. All assignments must be written as clearly and cleanly as possible (i.e. watch the typos, grammar, hanging sentences, etc.), in a formal but accessible academic language. The “look and feel” must be professional, and figures and tables should, where possible, be included in the text, not at the end of the document.

Referencing

Students are expected to have taken the "Cite it right" workshop and are encouraged to review the material it covers. Consistent quotation and citation is required and an excellent safeguard against inadvertent plagiarism.

Images

“Students can include copyrighted images in their assignments as long as they follow the Canadian Copyright Act’s current exceptions for fair dealing, in that the images must only be used for the purposes of criticism or review, and each image must be accompanied by:

(a) the source; and
(b) the name of the author(s) (if given in the source).

Acceptable Secondary Sources
“As graduate students, you will be expected to use a majority of academic (i.e. peer reviewed) sources when writing your term paper. Students are very much allowed, but not at all limited, to use course readings and other sources referenced in lectures in their own papers. Additional sources and relevant journals that are recommended by the instructor are also acceptable. However, students are strongly encouraged to track down those resources that are best suited to their specific area of interest or inquiry, rather than rely too heavily on those provided in class.

For cutting edge information, news, announcements, etc., popular press articles are of course acceptable. But these should be used to supplement or update rather than replace peer reviewed sources, and should never be used to explain a theoretical concept. They should also come from credible, verifiable sources, who have the credentials (whatever these may be) to back up their claims. Often these articles point to underlying scholarly articles in peer reviewed journals or conferences, students are encouraged to pursue.”

**Late Papers**

“Unless a formal extension has been negotiated with the instructor in advance of the due date, late assignments (defined here as an assignment submitted after the deadline) will be penalized by one full letter grade per 24 hours (e.g. from A to A-), for a maximum of 72 hours. After that point, late assignments will no longer be accepted. Furthermore, late papers will not receive detailed feedback or comments.”

**Extensions**

“Extensions on assignments within the term must be negotiated in advance, and require supporting documentation (e.g. doctor’s note). Students must email requests for extensions to the instructor at least 24 hours prior to the due date. Exceptions will only be made in extenuating circumstances. Extensions beyond the end of the term in which a course is taken are subject to the guidelines established by the School of Graduate Studies (Which can be found here: [http://www.sgs.utoronto.ca/informationfor/students/track/extsn.htm](http://www.sgs.utoronto.ca/informationfor/students/track/extsn.htm)).”

**Plagiarism**

Plagiarism is a serious offence. Offenders will be prosecuted. See U of T SGS Calendar and FIS policies. All sources must be cited fully and properly. Students are expected to have attended the "Cite it right" workshop offered by the Inforum.

**Grading**

“Grading for this course will follow the iSchool’s official *Guidelines to Grade Interpretation* of letter grades, as well as the University’s policy on *Graduate Grading and Evaluation Practices*. These sources define grades in the A range as “excellent” and grades in the B range as “good.” Please refer to the guidelines for detailed descriptions of these categories. Assignments will be graded and returned within 2-3 weeks of submission.” The blog posts will be given a mark at the end of the term.
Ground Rules

“Each student in this course is responsible for keeping up with the course materials, which includes (all) the required course readings, as well as topics, debates, and concepts discussed in class. Students are expected to attend lectures and to take their own lecture notes. You are expected to participate in class discussions, and are encouraged to use your laptops/mobile devices during class to look up relevant information that will contribute to the discussion in a meaningful way. At all times, however, remember to be respectful of the instructor and of your classmates – turn your phone function off, turn off the sound on your computer, and be sure not to browse any websites that may be offensive or illegal, or that might be deemed irrelevant to the task of taking this course. Students should arrive on time and are expected to stay for the duration. If you miss a class, you are responsible for obtaining any information or materials given in class, either from your classmates or online. Unauthorized recording of the lectures is not permitted.”

Students with a Disability or Health Consideration

“Students with diverse learning styles and needs are welcome in this course. If you have a disability or health consideration that may require accommodations, please feel free to approach the instructor and/or the Accessibility Services Office (http://www.accessibility.utoronto.ca/) as soon as possible. The Accessibility Services staff is available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. The sooner arrangements are made - the quicker we can assist you.”

Writing Support

“The SGS Office of English Language and Writing Support provides free writing support to graduate students. Services are designed for both native and non-native speakers of English, and include non-credit courses, single-session workshops, individual writing consultations, and online resources. Students are encouraged to use these services as needed.”

Academic Integrity

“The iSchool has a strict zero-tolerance policy on plagiarism, as defined in section B.I.1. (d) of the University’s Code of Behavior on Academic Matters. Before you embark on your first writing assignment, please make sure that you:

- Consult the University’s site on Academic Integrity: http://www.utoronto.ca/academicintegrity/
- Acquaint yourself with the Code and Appendix “A” Section 2; http://www.governingcouncil.utoronto.ca/policies/behaveac.htm
- Review the material you covered in Cite it Right;
- Consult the site How Not to Plagiarize: http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize”
# Schedule of Lecture Topics and Readings

<table>
<thead>
<tr>
<th>Week 1: Jan 12</th>
<th><strong>Introduction:</strong> systems + requirements + architecture + design = ?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Required Reading:</strong></td>
<td>- Carroll, J. (2000) <em>Making use: scenario-based design of human computer interactions</em>. MIT Press. (24x7 ebook available online through UTL) - Chapter 2: What is Design?</td>
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<td></td>
<td>- ABD Chapter 1: Introduction</td>
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<td></td>
<td>- RR Chapter 2: Requirements Process</td>
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<td>Week 2: Jan 19</td>
<td><strong>Stakeholders, context, goals, and &quot;the system&quot;</strong></td>
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<td></td>
<td>- RR chapter 4: Business Use Cases</td>
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<td></td>
<td>- Review the Volere template and associated examples in detail (see Blackboard)</td>
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<tr>
<td><strong>Supplementary Sources:</strong></td>
<td>- RR chapter 3</td>
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<td></td>
<td>- ABD chapters 2,3,4</td>
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<td></td>
<td>- Larman chapter 1: Object-oriented analysis and design</td>
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<tr>
<td>Week 3: Jan 26</td>
<td><strong>Scenarios and social modelling</strong></td>
</tr>
<tr>
<td><strong>Required Reading:</strong></td>
<td>- Carroll, J. (2000) <em>Making use: scenario-based design of human computer interactions</em>. MIT Press. (24x7 ebook) - Chapter 3: Scenario-Based Design</td>
</tr>
<tr>
<td></td>
<td>- Larman chapter 6: “Use cases”</td>
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<tr>
<td><strong>Supplementary Sources:</strong></td>
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### Week 4: Feb 2

**Scenarios, goals, and quality. Solution-oriented requirements.**

**Required Reading:**
- Pohl chapter 13: Fundamentals
- ABD chapter 9: Measurement

**Supplementary Sources:**
- For i*, see the road map at [http://www.cs.toronto.edu/km/istar/](http://www.cs.toronto.edu/km/istar/)
- Pohl chapter 13: Fundamentals
- Pohl chapter 17: Natural Language Requirements
- Pohl chapter 18: Structuring Natural Language Requirements

### Week 5: Feb 9

**From requirements to architecture (and back)**

**Required Reading:**
- WBD Chapter 12: System Design —or—
- SJD chapter 9: Moving to Design (p320-334)
- RW chapter 2
- BCK Chapter 1: What is Software Architecture?

**Recommended reading:**
- BCK Chapter 2: Why is Software Architecture Important?
### Supplementary sources:
- BCK Chapters 3, 4
- Pohl chapter 19: Fundamentals of Conceptual Modelling

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<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Feb 16</td>
<td>Reading week</td>
</tr>
<tr>
<td>Week 6:</td>
<td>No class this week.</td>
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<tr>
<td>Feb 23</td>
<td>Combined requirements reports are due.</td>
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<tr>
<td>Week 7:</td>
<td>Requirements presentations part 1</td>
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<tr>
<td>March 1</td>
<td>Elicitation, negotiation and documentation</td>
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### Required Reading:
- RW chapter 3

### Recommended Reading:

### Supplementary sources:
- Pohl chapters 17,18,19
### Week 8: Mar 8

**Requirements presentation part 2. System architecture and design**

**Required Reading:**
- RW chapter 5
- Review Rozanski & Wood: *Viewpoints and Perspectives Reference Card* (see Blackboard)
- BCK Chapter 17: Designing an Architecture

**Supplementary Sources:**

### Week 9: Mar 15

**Architecture documentation and evaluation. Design patterns.**

**Required Reading:**
- RW chapter 13
- RW architecture template (see Blackboard)

**Recommended reading:**
  Chapter 6: Guidelines for Modelling

**Supplementary Sources:**
- Microsoft Application Architecture, esp. Chapter 21-25
<table>
<thead>
<tr>
<th>Week 10: Mar 22</th>
<th>Service oriented architecture, mobile services, and cloud computing.</th>
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<tr>
<td><strong>Required Reading:</strong></td>
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<tr>
<td><strong>Recommended Readings:</strong></td>
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<tr>
<td><strong>Supplementary Sources:</strong></td>
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<tr>
<td>Week 11: Mar 29</td>
<td>Final presentations part 1, and discussion</td>
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<tr>
<td><strong>Recommended Reading:</strong></td>
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</table>
### Supplementary Reading:

### Supplementary Reading:

### Week 12: April 5
**Final presentations part 2, and discussion.**
**Wrap-up: Requirements and architecture**

#### Recommended Reading:
- Becker, Christoph; Betz, Stefanie; Chitchyan, Ruzanna; Duboc, Leticia; Easterbrook, Steve M.; Penzenstadler, Birgit; Seyff, Norbet; Venters, Colin C., *Requirements: The Key to Sustainability*. IEEE Software 33(1), 56-65, Jan.-Feb. 2016. [http://dx.doi.org.myaccess.library.utoronto.ca/10.1109/MS.2015.158](http://dx.doi.org.myaccess.library.utoronto.ca/10.1109/MS.2015.158)

#### Supplementary Reading:

### Helpful resources

An interesting list of (Software Engineering) literature discussing architectural issues in mobile application services can be found at [https://mobis.informatik.uni-hamburg.de/teaching/mobilearc-ws-13-14/#RecommendedLiterature](https://mobis.informatik.uni-hamburg.de/teaching/mobilearc-ws-13-14/#RecommendedLiterature)

### Contacting the Instructor & Supporting Instructor

Prof Christoph Becker is available by email: christoph.becker@utoronto.ca. Usual response time: within 2 working days.

Office hours: Tuesday 4pm-5.30pm. (No office hours on Feb 16, Feb 23).

**Acknowledgement and citation.** This syllabus partially builds on Prof. Eric Yu's course syllabus ([http://yu.ischool.utoronto.ca/1342outline.htm](http://yu.ischool.utoronto.ca/1342outline.htm)). The text in sections Website/Resources, Guidelines for Assignments, Grading, Ground Rules, Students with a Disability or Health Consideration, Writing Support, and Academic Integrity are in quotes because they are taken directly from Prof. Sara Grimes' Research Course Syllabus.