

University of Toronto Department of Computer Science

**CSC2106S**  
**Requirements Engineering**

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**Today's Menu**

**Start Here**

**This Week:**  
 Aims of the course  
 Syllabus  
 Readings  
 Definitions

**Next Week:**  
 Basics of RE  
 Approaches to RE  
 Nature of Requirements  
 Role of modeling

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**Course Objectives**

- **Examine the state-of-the-art for research & practice in Requirements Engineering.**
  - ↳ Role of RE in software and systems engineering
  - ↳ Current techniques, notations, methods, processes and tools used in RE
- **Gain practical experience in selected RE techniques**
- **Understand the essential nature of RE**
  - ↳ Breadth of skills needed for RE, and the many disciplines on which it draws
  - ↳ Contextual factors & practicalities
- **Gain a basic grounding for research in RE**
  - ↳ Methodological issues for RE research
  - ↳ Current research issues & direction of the field
  - ↳ Awareness of the literature

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**Teaching and Assessment**

- **1 x 3 hour seminar per week (13 weeks)**
  - ↳ Discussion of weekly reading material
  - ↳ Student presentations
  - ↳ No more than 1 hour of "lecture" material from me.
- **Weekly readings**
  - ↳ 1 or 2 papers per week
  - ↳ plus various background reading
- **Assessments:**
  - ↳ 40% literature survey on a topic of your choice
  - ↳ 40% practical project, applying 1 or more RE techniques
  - ↳ 10% oral presentation on one or other of the above
  - ↳ 10% class discussion (lead a discussion on weekly reading)

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## Syllabus\*

- **Introductory stuff**
  - ↳ What is RE
  - ↳ Why is it important
- **Foundations**
  - ↳ inter-disciplinary aspects of RE
- **Basic RE activities**
  - ↳ Eliciting Requirements
  - ↳ Modelling and Analysing Requirements
  - ↳ Communicating Requirements
  - ↳ Agreeing Requirements
  - ↳ Evolving Requirements
- **Integrated Requirements Engineering**
  - ↳ Selecting RE methods
  - ↳ RE tools

\*not necessarily  
in this order!

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## (I) Introductory Stuff

- **RE in the engineering life cycle**
  - ↳ Dimensions of RE
  - ↳ essential RE process
- **What is a requirement?**
- **Importance of requirements**
- **The role of a specification**
- **Application Domains**
  - ↳ Information systems vs. embedded systems
- **Processes, Methods and Techniques**
- **RE groundwork**
  - ↳ feasibility, risk, concept of operations
  - ↳ human-centred development

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## (II) Foundations

<ul style="list-style-type: none"> <li>→ <b>Systems Theory</b> <ul style="list-style-type: none"> <li>↳ What is a system?</li> <li>↳ Control and evolution of systems</li> </ul> </li> <li>→ <b>Systems Engineering</b> <ul style="list-style-type: none"> <li>↳ Engineering lifecycles</li> </ul> </li> <li>→ <b>Maths &amp; Logic</b> <ul style="list-style-type: none"> <li>↳ First order logic</li> <li>↳ Modal, temporal, deontic and paraconsistent logics</li> <li>↳ Algebraic and relational models</li> </ul> </li> <li>→ <b>Computer Science</b> <ul style="list-style-type: none"> <li>↳ Automata Theory</li> <li>↳ Abstraction, Decomposition, and Object Orientation</li> <li>↳ Software Architecture &amp; Design Patterns</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>→ <b>Social Sciences</b> <ul style="list-style-type: none"> <li>↳ Anthropology &amp; Ethnomethodology</li> <li>↳ Organisational Behaviour</li> <li>↳ Social psychology</li> <li>↳ Political Science</li> </ul> </li> <li>→ <b>Cognitive Sciences</b> <ul style="list-style-type: none"> <li>↳ Cognitive psychology</li> <li>↳ Linguistics</li> <li>↳ Knowledge Representation (AI)</li> </ul> </li> <li>→ <b>Philosophy</b> <ul style="list-style-type: none"> <li>↳ Empiricism and the philosophy of science</li> <li>↳ Phenomenology, epistemology, &amp; ontology</li> <li>↳ Semiotics (...and LitCrit)</li> </ul> </li> </ul>
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## (III) Eliciting Requirements

- **Things to elicit**
  - ↳ System boundaries
  - ↳ Stakeholders & User Classes
  - ↳ Viewpoints
  - ↳ Goals and tasks
  - ↳ Scenarios/Use cases
- **Elicitation techniques**
  - ↳ Interviews, questionnaires, surveys, meetings
  - ↳ Prototyping
  - ↳ Ethnographic techniques
  - ↳ Knowledge elicitation techniques
  - ↳ Conversation Analysis
  - ↳ Text Analysis
- **The elicitation process**
  - ↳ Inquiry cycle
  - ↳ Use case analysis

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## (IV) Modelling & Analysing Requirements

- **Enterprise Modelling & Analysis**
  - ↳ Business rules and organisational structures
  - ↳ Goals, tasks and responsibilities
  - ↳ Soft Systems analysis
- **Data Modeling**
  - ↳ Entity Relationship Models
- **Behavioural Modelling & Analysis**
  - ↳ Structured Analysis
  - ↳ Objected-oriented Analysis
  - ↳ Formal Methods
- **Domain Modelling & Analysis**
  - ↳ Domain engineering and reuse
  - ↳ Domain-specific models
- **Modelling Non-functional Requirements (NFRs)**
  - ↳ Taxonomies of NFRs
  - ↳ Performance modelling and analysis
  - ↳ Usability modelling and analysis
  - ↳ Safety, security and reliability modelling and analysis
- **Analysing Requirements Models**
  - ↳ Validation and verification
  - ↳ Consistency checking
  - ↳ Animation
  - ↳ Automated reasoning
- **Tools**
  - ↳ CASE and meta-CASE
  - ↳ Formal Analysis Tools

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## (V) Communicating the Requirements

- **Specifications**
  - ↳ Documenting the requirements
  - ↳ Specification languages
  - ↳ Making requirements measurable
  - ↳ Contractual issues
- **Documentation Standards**
  - ↳ The role of standards in requirements engineering
  - ↳ Example standards: IEEE, DoD, ESA, ISO
- **Traceability**
  - ↳ Pre- and post-requirements traceability
  - ↳ Traceability matrices
  - ↳ The role of hypermedia and electronic documents
  - ↳ Design Rationale
- **Requirements Documentation Tools**
  - ↳ DOORS, RTM, Requisite Pro, etc.

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## (VI) Agreeing Requirements

- **Validating Customer Requirements**
  - ↳ Requirements reviews
  - ↳ Formal inspections and walkthroughs
  - ↳ Conducting a review
  - ↳ Prototyping
- **Negotiation and Conflict**
  - ↳ Computer-supported negotiation
  - ↳ Win-Win
  - ↳ Ontological approaches
- **Prioritising Requirements**
  - ↳ Incremental Development Processes
  - ↳ Quality Function Deployment (QFD)
- **Package selection**
  - ↳ The role of Commercial-Off-The-Shelf (COTS) components
  - ↳ Feature matching
- **Contextual issues**
  - ↳ Contractual issues
  - ↳ Political and organisational issues
  - ↳ Procurement and funding issues
- **Negotiation and Validation Tools**

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## (VII) Evolving Requirements

- **Managing Change**
  - ↳ Impact analysis
  - ↳ Baselines and change requests
  - ↳ Configuration management and version control
  - ↳ Requirements and software maintenance
- **Managing Inconsistency**
  - ↳ On the inevitable intertwining of inconsistency and change
  - ↳ Learning from inconsistency
  - ↳ Feature interaction
  - ↳ Living with inconsistency
- **Product Families**
  - ↳ Reuse of requirements
  - ↳ The role of COTS
  - ↳ The role of software architectures
- **Requirements Management Tools**

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## (VIII) Integrated RE Processes

- **Method Engineering**
  - ↳ Need for multiple Methods
  - ↳ Method Design and Meta-modelling
  - ↳ Method Selection
  - ↳ Method Integration
  - ↳ Method Customization
- **Problem Frames**
  - ↳ Analysis patterns
  - ↳ Application Domains
- **Viewpoints-Oriented Requirements Engineering**
  - ↳ Multiple Perspectives
  - ↳ Decentralization of the RE process
  - ↳ Collaborative work and Concurrent Engineering
  - ↳ Viewpoint Integration
  - ↳ Translation between notations
- **The Requirements Process**
  - ↳ Choosing a Process Model
  - ↳ Types of Process
  - ↳ Process Improvement
- **Tool Support**
  - ↳ Meta-CASE
  - ↳ Tools for Meta-modeling
  - ↳ Tool Integration

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## Bibliography

- **Extensive list of books and papers!**
  - ↳ no one textbook covers the field well
  - ↳ this course is research-oriented:
    - we'll rely on recent papers more than books
    - most of the papers are available electronically
    - feel free to contact researchers directly for more papers, info, tools, etc.
- **To help navigate the literature:**
  - ↳ <http://www.cs.toronto.edu/~sme/CSC2106S/readings.pdf>
    - provides a detailed bibliography, arranged according to the topics on this course
  - ↳ <http://easyweb.easynet.co.uk/~iany/reviews/reviews.htm>
    - Book reviews by Ian Alexander
  - ↳ <http://www.rmplace.org/>
    - Al Davis' bibliography and other RE related links
  - ↳ See also the resource list on the course website

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## Many books on RE exist

### Student textbooks

- A. Davis, *Software requirements: objects, functions and states*, Prentice Hall, 1993.
- G. Kotonya and I. Sommerville, *Requirements Engineering: Processes and Techniques*, Wiley, 1998.
- P. Loucopoulos and V. Karakostas, *System Requirements Engineering*, McGraw Hill, 1995.
- L. A. Macaulay, *Requirements Engineering*, Springer Verlag, 1996.
- R. J. Wieringa, *Requirements Engineering: Frameworks for Understanding*, Wiley, 1996.
- Flynn, D., *Information Systems Requirements: Determination and Analysis*, McGraw Hill, 1992

### Collected Readings

- R. H. Thayer and M. Dorfman (eds.), *Software Requirements Engineering*, Second Edition, IEEE Computer Society Press, 1997.
- J. Goguen, and M. Jirotko (Eds.), *Requirements Engineering: Social and Technical Issues*, Academic Press, 1994.

### Practitioner textbooks

- S. J. Andriole, *Managing Systems Requirements: Methods, Tools, and Cases*, McGraw-Hill, 1996.
- D. C. Gause and G. M. Weinberg, *Exploring Requirements: quality before design*, Dorset House, 1989.
- D. C. Gause and G. M. Weinberg, *Are Your Lights On?: How to Figure Out What the Problem Really Is*, Dorset House, 1990.
- J. O. Grady, *System Requirements Analysis*, McGraw Hill, 1993.
- I. S. Graham, *Requirements Engineering and Rapid Development: A Rigorous, Object-Oriented Approach*, Addison-Wesley, 1998.
- B. L. Kovitz, *Practical Software Requirements: A Manual Of Content And Style*, Manning Publications, 1998
- K. L. McGraw and K. Harbison, *User-Centered Requirements: The Scenario-Based Engineering Process*, Lawrence Erlbaum Associates, 1997.
- J. Robertson and S. Robertson, *The Complete Systems Analysis*, Dorset House, 1998.
- G. Schneider and J. P. Winters, *Applying Use Cases: A Practical Guide*, Addison-Wesley, 1998.
- I. Sommerville and P. Sawyer, *Requirements Engineering: A Good Practice Guide*, Wiley, 1997.
- R. Stevens, K. Jackson, P. Brook, and S. Arnold, *Systems Engineering: Coping with Complexity*, Prentice-Hall 1998.

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## Research Literature

### Conferences

- ↳ IEEE International Symposium on Requirements Engineering
  - RE'93 - Jan 4-5, 1993, San Diego, USA
  - RE'95 - Mar 27-29, 1995, York, UK
  - RE'97 - Jan 6-10, 1997, Annapolis, USA
  - RE'99 - Jun 7-11, 1999, Limerick, Ireland
  - RE'01 - Aug 26-31, 2001, Toronto, Canada
- ↳ IEEE International Conference on Requirements Engineering
  - ICRE'94 - Apr 1994, Colorado Springs, USA.
  - ICRE'96 - Apr 15-18, 1996, Colorado Springs, USA.
  - ICRE'98 - Apr 6-10, 1998, Colorado Springs, USA.
  - ICRE'00 - Jun 19-23, 2000, Chicago, USA
- ↳ In 2002, ICRE and RE merged...
- ↳ IEEE International Requirements Engineering Conferences
  - RE'02 - September 2002, Essen, Germany
  - RE'03 - September 2003, Monterey Bay, USA

### Journals

- ↳ Requirements Engineering Journal
  - published quarterly by Springer
- ↳ IEEE Transactions on Software Engineering
  - (published monthly)
- ↳ ACM Transactions on Software Engineering and Methodology
  - (published quarterly)
- ↳ Various other SE journals:
  - Annals of Software Engineering
  - Software Practice and Experience
  - Automated Software Engineering
  - Journal of Systems and Software

### Workshops

- ↳ IWSSD - Int. Workshops on Software Specification and Design
- ↳ REFSQ - Int. Workshops on Requirements Engineering: Foundations of Software Quality

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