Masters of Science in Software & Information Systems

To be developed and delivered in conjunction with Regis University, School for Professional Studies

Object Oriented Design

January 2009

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Section 2 Module Details

Programme Title: M.Sc. in Software and Information Systems

Module Name: Object Oriented Design

Course Description:
This module will build on the knowledge acquired by students in their software engineering module, and provide a comprehensive introduction to the field of Object Oriented Design and the Unified Modeling Language (UML). Students will be introduced to the various object oriented analysis and design techniques which have developed over time, and will learn the industry-standard notation, UML (Unified Modeling Language). This industry standard notation is covered from its original inception, through its various constituent models, and on to its practical use in systems development (Note: this module is based on UML2, the latest version of the UML notation, approved in 2004). The application of UML is explored from analysis through design and on to final system implementation, highlighting the strengths of object orientation as an approach to systems development where the one notation is used throughout. Students will develop object oriented analysis and design models using Computer Aided Software Engineering (CASE) tools, similar to those developed in the software engineering module. The challenges of progressing seamlessly from system inception, through analysis, solution design and technical implementation will be addressed, while maintaining a focus on the delivery of a quality system within timescale and budget.

Prerequisites:
Students taking this module will already have completed the software engineering module, and the system analysis and design techniques learned therein will provide a sound basis for the new systems development material presented in this OOD module. Some students may have already taken object oriented programming as an optional module, and this module will build on the object oriented concepts covered there, providing a broader view of the use of object orientation in the whole systems development process, as opposed to the OOP focus on code development and implementation. The object oriented programming module is not a prerequisite for this module, however, and object oriented concepts will be covered in the introductory section of this course.
**Course Objectives:**
At the end of the module, students are expected to be able to competently:

- Discuss and explain general concepts related to Object Orientation and particularly Object Oriented Analysis and Design.
- Gather a clear set of requirements from clients for a software system.
- Analyse a business’ requirements, and develop an object oriented domain model from those requirements, clearly identifying the domain classes.
- On further analysis, progress from the domain model to an object oriented application model for those requirements, clearly identifying the application artefacts required.
- Evaluate the potential for reuse in the design of a system solution: from patterns to commercially available components.
- Produce an object oriented design model for the proposed system solution.
- Prepare relevant UML implementation models for this system solution.
- Evaluate issues related to the implementation of the proposed system wrt resource usage, security, maintenance and performance.
- Compare the Unified Process with agile process approaches.

**Required Texts:**
Selected chapters and sections from the following two texts will be presented as part of the core content of this module:


  ISBN: 0-321032127-8

**Course Emphasis on Fundamental Skills:**
This course emphasises the development of object oriented systems analysis and design skills, specifically UML2 techniques, by the individual student (Class Models, State Models, Interaction Models, Use Case Models, and system design...
and implementation diagrams) for use throughout the Systems Development Lifecycle (SDLC). These skills are taught within the overall context of quality systems development.

Students complete their lab exercises using their Citrix account in the selected Computer Aided Software Engineering (CASE) tool (most likely Rational Rose). Accounts will be assigned to all students by the facilitator at the beginning of the module.

Course Assignments:
Student assessment will take the form of:
- Weekly assessments to be completed, sometimes in the Virtual Lab
- A Final Exam consisting of both practical OOD tasks and theoretical questions

Grading:
The balance of these marks reflects overall degree requirements and specific workshop assignments/labs within this module.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Weight</th>
<th>Workshop</th>
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<tr>
<td>Participation</td>
<td>15%</td>
<td>1-8</td>
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<tr>
<td>Final Exam</td>
<td>25%</td>
<td>8</td>
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<tr>
<td>Weekly assessments</td>
<td>60%</td>
<td>1-7</td>
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<tr>
<td>Total</td>
<td>100%</td>
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## Course Outline:

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Text Reading</th>
<th>Topics</th>
<th>Assessments to be completed</th>
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<tr>
<td>Workshop 1</td>
<td><strong>Object-Oriented Modeling and Design with</strong> UML Chapters 1 and 2</td>
<td>- Introduction to Object Oriented Design</td>
<td>Research Assignment: Software Process</td>
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<tr>
<td></td>
<td><strong>UML2 and The Unified Process Chapter 1</strong></td>
<td>- Introduction to the Unified Modeling Language (UML)</td>
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<tr>
<td>Workshop 2</td>
<td><strong>Object-Oriented Modeling and Design with</strong> UML Chapter 7, Section 7.1;</td>
<td>- Problem Statements: Requirements</td>
<td>Assignment: Use Case Model to be completed for problem statement</td>
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<td></td>
<td>Chapter 8: Section 8.1</td>
<td>- Domain Analysis: Use-Case Models</td>
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<td></td>
<td><strong>UML2 and The Unified Process Chapters 3, 4, 5</strong></td>
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<td>Workshop 3</td>
<td><strong>Object-Oriented Modeling and Design with</strong> UML Sections of Chapters 3 and</td>
<td>- UML Class Model</td>
<td>Assignment: Class Modeling exercise to be completed using CASE tool</td>
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<td>Chapter 4</td>
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<td></td>
<td>**UML2 and The Unified Process Sections of Chapters 6, 7, 8, 9, 10 and 11</td>
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<td>Workshop 4</td>
<td><strong>Object-Oriented Modeling and Design with</strong> UML Chapter 7: Sections 7.2 and</td>
<td>- UML Interaction Model</td>
<td>Assignment: Interaction Model to be completed for exercise using CASE tool</td>
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<td>7.3, Chapter 8: Sections 8.2 and</td>
<td>- UML Activity Diagrams</td>
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<td>Workshop 5</td>
<td><strong>Object-Oriented Modeling and Design with UML</strong></td>
<td>Workshop 6</td>
<td><strong>Object-Oriented Modeling and Design with UML</strong></td>
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<td><em>UML State Model</em></td>
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<td><em>System Design: Architecture and Patterns</em></td>
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<td><em>Analysis Case Study: Restaurant System</em></td>
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<td><em>System Design: HIC, TMC, DMC</em></td>
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<td><strong>Assignment: State Modeling</strong> assignment to be completed using CASE tool**</td>
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<td><strong>Research Assignment: Design Patterns</strong></td>
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<td>Workshop 7</td>
<td><strong>Object-Oriented Modeling and Design with UML</strong></td>
<td>Workshop 8</td>
<td><strong>Object-Oriented Modeling and Design with UML</strong></td>
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<td><em>Detailed Class Design</em></td>
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<td><em>Comparison of OO and other lifecycle approaches</em></td>
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<td><em>OO Implementation: UML implementation Diagrams</em></td>
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<td><em>Revision</em></td>
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<td><em>Implementation: Languages and Databases</em></td>
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<td><strong>Assignment: Create Implementation model for assignment using CASE tool.</strong></td>
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Section 3  Workshop Syllabus

Workshop One: Introduction to Object Oriented Design and UML2:

Assignments/ readings to be completed before Workshop 1:

1. Read
   Object-Oriented Modelling and Design with UML Chapters 1 and 2
   UML2 and The Unified Process Chapter 1

List of topics for Workshop One:

- Object oriented constructs and themes.
- Object oriented modelling and design.
- Object oriented modelling history.
- UML and UML2.
- UML Common Mechanisms.
- The three models: class, state and interaction.
- The Unified Process

Course objectives for Workshop One:

Upon completion of this workshop students will be able to competently:

1. Define what is meant by object orientation
2. Define UML
3. Explain key concepts of object oriented approaches to systems development
4. Recognise the difference between object oriented implementation and object oriented development
5. Explain the evolution of UML 2, describing the progression from several disparate methodologies to one standard notation
6. Define each of the following models:
   a. Class Model
   b. State Model
   c. Interaction Model
7. Distinguish between the three different system models and recognise their overlap
8. Explain the UML’s four common mechanisms
9. Describe the application of these common mechanisms throughout UML
10. Define the Unified Process
11. Describe the Unified Process and how it can be applied on a project

**Suggested Activities/ Progress Checks/ Review Questions:**

1. Facilitator leads review/discussion of readings
2. Students conduct research relevant to assignment
3. Facilitator hands out assignments

**Lab Exercises for Workshop One:**
There are no lab requirements for Week one.

**Assignment(s) for Workshop One:**

1. Research Assignment: Find out what you can about the differences between heavyweight and lightweight or agile software process methodologies, paying particular attention to the Unified Process.
Workshop Two: System Requirements and Use Case Model

Assignments/ readings to be completed before Workshop Two:
1. Complete Week 1 assignments
2. Read: 
   Object-Oriented Modeling and Design with UML Chapter 7, Section 7.1; 
   Chapter 8: Section 8.1
   UML2 and The Unified Process Chapters 3, 4, 5

List of topics for Workshop Two:
- Requirements Analysis
- Requirements Analysis in UP
- Types of Requirements
- Requirements modeling
- Use Case Models
- Use Case Diagrams (UML Notation): Actors, Use Cases and Relationships
- Use Case Descriptions and Scenarios
- Use Case Modeling Process
- Advanced Use Case Relationships: includes, extends, and generalisation

Course Objectives for Workshop Two:
Upon Completion of this workshop, students are expected to competently:

1. Describe the importance of effective requirements engineering (collection and analysis) to system success
2. Identify the primary inputs and outputs of requirements analysis
3. Define the different types of system requirements
4. Compare the UML requirements model with the more traditional requirements model
5. Define use cases and use case diagrams
6. Explain the role of the use case view in the UML system architecture
7. Define scenarios and their use throughout UML modelling
8. How do you go about finding use cases?
9. Analyse problem descriptions and identify the use cases and actors therein
10. Construct UML use case diagrams
11. Create a web of scenarios for each use case
12. Identify the difference between an \textit{extend} relationship and an \textit{include} relationship between use cases

\textbf{Suggested Activities/ Progress Checks/ Review Questions:}

1. The facilitator reviews week 1 questions with the students.
2. The facilitator leads a review of week 2 readings.
3. The facilitator hands out Week 2 assignments.
4. The students complete their assignment using their lab accounts.

\textbf{Lab Exercises for Workshop Two:}

1. Students complete the introduction to Rational Rose tutorial using their lab accounts.
2. Students complete the models for Week two’s assignment using Rational Rose.

\textbf{Assignment(s) for Workshop Two:}

1. Complete Week 2 lab tutorial (as above).
2. Complete Week 2 assignment(s): Use Case model to be produced using Rational Rose.
Workshop Three: Class Model

Assignments/ readings to be completed before Workshop Three:
1. Complete Week 2 assignment
2. Read:
   Object-Oriented Modeling and Design with UML Chapter 3 and Chapter 4
   UML2 and The Unified Process Chapter 7 and Chapter 8

List of topics for Workshop Three:
- Objects and Classes
- Class Diagrams (UML Notation)
- Finding Classes (CRC)
- Values and Attributes
- Operations and Methods
- Links and Associations
- Multiplicity
- Generalisation and Inheritance
- Abstract Classes
- Packages (Arlow and Neustadt chapter 11)
- Testing

Course Objectives for Workshop Three:
Upon completion of workshop three, students will be able to competently:

1. Define an object and class
2. Explain the representation of classes (attributes, operations and interactions) in class diagrams
3. Describe UML class diagram notation
4. Analyse problem descriptions and identify the classes and their associated attributes therein
5. Identify the operations required by these classes
6. Be able to identify the interactions between the classes and the required relationships between them
7. Construct UML class diagrams from the above
8. Create hierarchies of classes using generalisation and inheritance
9. Define UML packages
10. Define dependencies between packages
11. Apply packages to systems analysis problems to organise the system solution
12. Test class model against user expectations
13. Navigate through Rational Rose
14. Open projects and create class diagrams in Rational Rose

**Suggested Activities/ Progress Checks/ Review Questions:**

1. The facilitator reviews week 2 questions with the students.
2. The facilitator leads a review and discussion of week three’s assigned readings.
3. The facilitator hands out Week 3 assignment:
4. The students complete their assignment in Rational Rose using their lab accounts.

**Lab Exercises for Workshop Three:**

1. Complete the Class model, using Rational Rose, for week three’s assigned exercise.

**Assignment(s) for Workshop Three:**

1. Complete Week 3 assignment: Class model to be produced using Rational Rose
Workshop Four: Interaction Model

Assignments/ readings to be completed before Workshop Four:

1. Complete Week 3 assignments
2. Read:
   - Object-Oriented Modeling and Design with UML Chapter 7: Sections 7.2 and 7.3, Chapter 8: Sections 8.2 and 8.3. Chapters 12 and 13.
   - UML2 and The Unified Process Chapter 12, and Chapter 13

List of topics for Workshop Four:

- Application Model
- Modeling dynamic system behaviour
- Interaction Diagrams
- Sequence Diagrams
- Testing

Course Objectives for Workshop Four:

Upon completion of workshop five students will be able to competently:

1. Define sequence diagrams
2. Explain the use of interaction diagramming in UML
3. Describe UML sequence diagram notation
4. Identify relationship between use case diagrams and sequence diagrams
5. Construct UML sequence diagrams for each use case
6. Test interaction diagrams against user expectations
7. Create sequence diagrams in Rational Rose
8. Define activity diagrams and their role in UML
9. Define activities
10. Define the three types of node:
    a. action
    b. control and
    c. object
**Suggested Activities/ Progress Checks/ Review Questions:**

1. The facilitator reviews week three questions with the students.
2. The facilitator leads a review of the readings for week four.
3. The facilitator hands out week four's assignment:
4. The students complete their assignment using Rational Rose in their lab accounts.

**Lab Exercises for Workshop Four:**

1. Complete the models, using Rational Rose, for week four’s assigned exercise.

**Assignment(s) for Workshop Four:**

1. Complete Week 4 assignment(s): Interaction model to be produced using Rational Rose.
Workshop Five: State and Activity Models

Assignments/ readings to be completed before Workshop Five:

1. Complete Week 4 assignments
2. Read:
   Object-Oriented Modelling and Design with UML Chapter 5 and Chapter 6 (leave out sections 6.3 and 6.)
   
   UML2 and The Unified Process Chapter 21 and Chapter 22 (leave out sections 22.3, 22.4 and 22.5)

List of topics for Workshop Five:

- State Model and Object Behaviour
- Events and States
- Transitions and Conditions
- State Diagrams (UML Notation)
- Nested State Diagrams
- Relation of Class and State models
- Relation of all Analysis models
- Relationship among UML models
- System Analysis: Domain and Application Models
- Analysis Case Study

Course Objectives for Workshop Five:

Upon completion of workshop five students will be able to competently:

1. Define events and states
2. Define transitions and conditions
3. Define state diagram activities
4. Explain the integration of all above elements in state diagrams
5. Describe UML state diagram notation
6. Analyse problem descriptions and identify the various changes of state for each class with important temporal behaviour
7. Identify the events and responses to events for these state changes
8. Construct UML state diagrams for these classes
9. Create nested state diagrams
10. Test state model against user expectations
11. Create state diagrams in Rational Rose
12. Define a domain model and its associated components
13. Analyse a set of requirements and identify the key classes, and their attributes, behaviour, interactions
14. Construct a domain model for a set of requirements
15. Construct an application model from the domain model for a set of requirements
16. Test domain and application models against user requirements

**Suggested Activities/ Progress Checks/ Review Questions:**

1. The facilitator reviews week 4 questions with the students.
2. The facilitator leads a review and discussion of week five's assigned readings.
3. The facilitator hands out Week 5 assignment: State Model.
4. The students complete their assignment using Rational Rose in their lab accounts.

**Lab Exercises for Workshop Five:**

1. Complete the models, using Rational Rose, for week four's assigned exercise.

**Assignment(s) for Workshop Five:**

1. Complete Week 5 assignment(s): State model to be produced using Rational Rose
Workshop Six: System Design

Assignments/ readings to be completed before Workshop 6

1. Complete Week 5 assignments
2. Read:
   - Object-Oriented Modeling and Design with UML Chapter 14
   - UML2 and The Unified Process Chapter 16 and Chapter 19

List of topics for Workshop Six:

- System Design
- Architecture: Packages, Subsystems
- Subsystems and concurrency
- Reuse: Frameworks, Patterns, Components
- Design Patterns
- UML Human Interaction Component
- UML Data Management Component
- UML Task Management Component
- System Testing

Course Objectives for Workshop Six:

Upon completion of this workshop students will be able to competently:

1. Define object oriented system design and distinguish it from OO analysis
2. Define frameworks and patterns
3. Create a high level strategy for solving the analysed problem - the system architecture
4. Estimate system performance
5. Identify useful design patterns and describe their contribution to system design
6. Make a reuse plan
7. Organise a system solution into subsystems
8. Identify system concurrency
9. Manage data stores
10. Manage system boundaries
11. Design UI classes to handle human interaction
12. Test system design and simulate its performance
13. Identify common architectural styles and their relative merits
14. Select appropriate architectural styles for different system implementation problems

**Suggested Activities/ Progress Checks/ Review Questions:**

1. Facilitator reviews questions from workshop 5 with the students.
2. Facilitator leads review/discussion of readings for week 6.
3. Facilitator hands out assignment(s) for workshop 6.
4. The students complete their research assignment for Week 6.

**Lab Exercises for Workshop Six:**

1. There are no lab requirements for this week.

**Assignment(s) for Workshop Six:**

1. Complete Week 6 research assignment(s) on Design Patterns.
Workshop Seven: Detailed Design and System Implementation

Assignments/ readings to be completed before Workshop 7

1. Complete Week 6 assignments
2. Read:
   Object-Oriented Modeling and Design with UML Chapters 15, 17, 18, 19
   UML 2 and The Unified Process Chapters 17, 18, 23, and 24

List of topics for Workshop Seven:

- Class Design
- Realising Use Cases
- Refactoring and Design Optimisation
- Design Quality: Cohesion and Coupling
- Aggregation and Inheritance
- Implementation Diagrams
- Component model
- Deployment model
- System testing

Course Objectives for Workshop Seven:

Upon completion of this workshop students will be able to competently:

1. Complete the definition of classes and associations begun in analysis
2. Realise use cases with operations
3. Formulate algorithms for each operation
4. Refactor design model produced for a cleaner design
5. Adjust class structure to increase inheritance
6. Define system implementation
7. Define UML system implementation models
8. Construct UML deployment model for a system implementation
9. Construct UML component models for system implementation
10. Generate test data from use case scenarios: typical and exceptional
11. Unit test each class
12. Perform integration testing and analyse the system performance
**Suggested Activities/ Progress Checks/ Review Questions:**

1. Facilitator reviews questions from workshop 6 with the students.
2. Facilitator leads review/discussion of readings assigned for Week 7.
3. Facilitator hands out assignments for Week 7.
4. Students complete their assignment for week 7 in Rational Rose using their lab accounts.

**Lab Exercises for Workshop Seven:**

1. Complete the models, using Rational Rose, for Week seven's assigned lab exercise.

**Assignment(s) for Workshop Seven:**

1. Extend earlier Domain model with design detail using Rational Rose
2. Complete implementation model using Rational Rose
Workshop Eight: OOD in Context and Final Exam

Assignments/ readings to be completed before Workshop 8

1. Complete Week 7 assignment(s)
3. Read:  
   Object-Oriented Modeling and Design with UML Chapter 21

List of topics for Workshop Eight:

- Final Exam

Suggested Activities/ Progress Checks/ Review Questions:

1. Conclude all course lecture topics and conduct a final Q&A session
2. Facilitator distributes final exam.
3. Students complete the final exam
4. Student representative will distribute the Course Evaluation Forms to students and ensure that these are returned to course facilitator.
Section 4  Appendices

(a) Grading Criteria for Written Submissions
A standard template will be devised for this section, however if writers are using a grading template for similar courses, please include here for discussion with Faculty group.

(b) Evaluation of Oral/ Group Presentations (if applicable)
A standard template will be devised for this section, however if writers are using a grading template for similar courses, please include here for discussion with Faculty group.

(c) References
Please list.

(d) Information Sources
Please list.

(e) Guidelines for software piracy, plagiarism, using sources in academic works
Standard response will be provided in each module handbook.