



LEVEL 5

ANALYSIS, DESIGN AND IMPLEMENTATION

Student Guide



Modification History

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1. Module Overview and Objectives

The aim of this unit is to develop knowledge, skills and experience in the use of object-oriented techniques for the development of software. The module aims to develop expertise in:

- object-oriented analysis
- object-oriented design
- object-oriented coding
- the testing of systems

2. Learning Outcomes and Assessment Criteria

Learning Outcomes; The Learner will:	Assessment Criteria; The Learner can:
1. Understand the seamless transition from OO analysis to OO design.	1.1 Explain the seamless transition from OO analysis to OO design 1.2 Identify and describe OO analysis models 1.3 Identify and describe OO design models
2. Understand how to convert OO analysis and design models to code	2.1 Explain how to convert OO analysis models to code 2.2 Explain how to convert OO design models to code
3. Understand the quality attributes associated with an OO development	3.1 Explain the developer software quality attributes 3.2 Explain the user software quality attributes
4. Understand the concept of maintenance within an OO development environment	4.1 Describe what is meant by maintenance of software 4.2 Identify and define the different types of software maintenance
5. Be able to produce OO analysis and design models using a case tool	5.1 Use a case tool to produce OO analysis models based on a case study 5.2 Use a case tool to develop OO design models based on a case study
6. Be able to convert OO analysis and design models to code using an appropriate IDE	6.1 Use an IDE to develop code based on an OO analysis model 6.2 Use an IDE to develop code based on an OO design model
7. Be able to refactor an OO program to improve quality	7.1 Refactor code based on standard refactoring techniques.

3. Syllabus

Syllabus			
Topic No	Title	Proportion	Content
1	Introduction to the module	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> • Introduction to the module • Distinction between analysis and design • The Software Crisis • Recap of key OO concepts <p>Learning Outcomes: 1</p>
2	Introduction to StarUML	1/12 1 hours of lectures 3 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> • Obtaining and using the module OO Case tool • Turning simple models into code <p>Learning Outcomes: 5 & 6</p>
3	Object-Oriented Modelling	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> • Discussion of the OO software development process • Use case diagrams • Identifying abstractions • Event Decomposition • Discussion of benefits of OOAD • Discussion of drawbacks of OOAD <p>Learning Outcomes: 1 & 5</p>
4	Static Modelling in UML	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> • Requirements gathering • Natural Language Analysis • Candidate classes • Class diagrams • Converting class diagrams into code <p>Learning Outcomes: 1 & 5</p>
5	Dynamic Analysis and Design	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> • Activity diagrams • Sequence diagrams • Converting dynamic models into code <p>Learning Outcomes: 1 & 5</p>

6	OOAD Case Study	1/12 1 hours of lectures 3 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Worked example from problem statement to design <p>Learning Outcomes: 1, 3 & 5</p>
7	Design Patterns 1	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Introduction to design patterns Factory Abstract Factory <p>Learning Outcomes: 2, 3 & 4</p>
8	Design Patterns 2	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Model-View-Controller Flyweight Strategy Facade <p>Learning Outcomes: 2, 3 & 4</p>
9	Elements of Good Design	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Software quality attributes Software component design Coupling Cohesion The Observer design pattern <p>Learning Outcomes: 3 & 5</p>
10	Redesign and Implementation	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Redesign of case study Incorporation of design patterns Implementation of elements of previous design case study into code <p>Learning Outcomes: 2 & 6</p>
11	Maintenance and Refactoring	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Impact of change Refactoring Refactoring case study <p>Learning Outcomes: 4 & 7</p>

12	Recap	1/12 2 hours of lectures 2 hours of laboratory sessions 1 hour of tutorials	<ul style="list-style-type: none"> Recap of module <p>Learning Outcomes: All</p>
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4. Related National Occupational Standards

The UK National Occupational Standards describe the skills that professionals are expected to demonstrate in their jobs in order to carry them out effectively. They are developed by employers and this information can be helpful in explaining the practical skills that you have covered in this module.

Related National Occupational Standards (NOS)
<p>Sector Subject Area: 6.1 ICT Professionals</p> <p>Related NOS:</p> <p>4.3.P.1 – Manage, under supervision, information to direct human needs analysis assignments; 4.3.P.2 – Produce, implement and maintain quality human needs analysis activities; 4.3.P.3 – Provide human needs analysis findings to others; 4.4.P.1 – Prepare, under supervision, for a systems analysis assignment; 4.4.P.2 – Carry out, as required, systems analysis activities; 4.4.P.3 – Monitor the effectiveness of systems analysis activities and their deliverables; 4.4.S.1 – Design, implement and maintain systems analysis activities; 4.7.P.1 – Prepare, under supervision, for system/solution/service design activities; 4.7.P.2 – Assist with the design of system/solution/service design; 4.7.P.3 – Monitor the progress of system/solution/service design activities; 5.1.S.2 - Initiate systems development activities; 5.3.S.3 - Manage systems development activities; 5.2.P.2 - Perform software development activities; 5.3.P.2 - Contribute to the communication of the results of IT/Technology solution testing; 5.3.S.1 - Implement the infrastructure for testing activities; 5.3.S.2 - Manage testing activities; 5.3.S.3 - Monitor and control testing activities.</p>

5. Teaching and Learning

Suggested Learning Hours					
Lectures:	Tutorial:	Seminar:	Laboratory:	Private Study:	Total:
22	12	-	26	90	150

The teacher-led time for this module is comprised of lectures, laboratory sessions and tutorials. You will need to bring this Student Guide to all classes for this module. The breakdown of the hours is also given at the start of each topic.

5.1 Lectures

Your lecturer will be presenting the basic knowledge and the theoretical concepts required for the unit during this time. He/she will use PowerPoint slides during the lecture time and you will be expected to take notes.

You will also be encouraged to be active during this time and discuss and/or practice the concepts covered. Lectures will include question and answer elements to promote participation and to allow your lecturer to check whether you understand the concepts they are covering.

5.2 Tutorials

These are designed to deal with the questions arising from the lectures and private study sessions. You should think carefully beforehand about any areas in which you might need additional guidance and support and use this time to discuss these with your teacher.

5.3 Laboratory Sessions

During these sessions, you are required to work through practical tutorials and various exercises. The details of these are provided in this guide.

5.4 Private Study

This Student Guide also contains details of the private study exercises. You are expected to complete these exercises to improve your understanding. Your tutor will set deadlines for the completion of this work and go over the suggested answers with you. The deadlines will usually be before the scheduled tutorials for that topic. Some of the private study tasks may require you to work in a small group so you will need to plan your time carefully and ensure that you can meet with your group members to complete the work required before the deadline.

You should also use this time to revise the content of lectures to ensure understanding and conduct extra reading (using the supplementary textbooks or other materials available in the library or online). You should bring any questions to the tutorial for additional guidance and support.

6. Assessment

This module will be assessed by means of an assignment worth 50% of the total mark and an examination worth 50% of the total mark. These assessments will be based on the assessment criteria given above and you will be expected to demonstrate that you have met the module's learning outcomes.

Assignments for this module will include topics covered up to and including Topic 7. Questions for the examination will be drawn from the complete syllabus.

7. Further Reading List

You will also be expected to undertake further reading to consolidate and extend your knowledge of the topics covered in this module. Your Accredited Partner Centre's library will contain a selection of useful sources of information and you can also make use of materials available online. The list below also provides suggestions of suitable reference books you may like to use:

Bevis, T. (2012). *Java Design Pattern Essentials*, 2nd edition Ability First Ltd.
ISBN-10: 095657846
ISBN-13: 978-0956575845

Gamma, E., Helm, R., Johnson, R. and Vlissides, K. (1994). *Design Patterns*. Pearson Addison Wesley.

ISBN-10: 0201633612

ISBN-13: 978-0201633610

Jackson, R., Burd, S. and Satzinger, J. (2004). *Object-oriented Analysis and Design with the Unified Process*. Course Technology Inc.

ISBN-10: 0619216433

ISBN-13: 978-0619216436

Larman, C. (2004). *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development*. Pearson Prentice Hall.

ISBN-10: 0131489062

ISBN-13: 978-0131489066

McGregor, J. and Sykes, D. (2001). *A Practical Guide to Testing Object-Oriented Software*. Pearson Addison Wesley.

ISBN-10: 0201325640

ISBN-13: 978-0201325645



Topic 1: Introduction to the Module

1.1 Learning Objectives

This topic provides an overview of the analysis and design. On completion of the topic, you will be able to:

- Define the need for software development techniques;
- Discuss the need for analysis in developing complex software;
- Discuss the need for design in developing complex software.

1.2 Timings

Lectures:	2 hours
Laboratory Sessions:	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

1.3 Laboratory Sessions

The time allocation for the laboratory sessions for this topic is 2 hours.

Activity 1:

Investigate the following concepts as discussed in the lecture:

1. The software crisis
2. The reasons why software products fail
3. Problem statements
4. The role of analysis versus design

Activity 2: Group Discussion

Work in small groups as directed by your tutor.

Making use of the insights and material you uncovered during Activity 1, discuss the need for formal analysis and design, and how it contributes to resolving some of the issues associated with the software crisis.

1.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

You should begin keeping a journal of important notes and concepts from the lecture. Supplement the material from each lecture with the results from your own studies. Each week, your guide will contain some topics for you to research and summarise - these will be your own personal revision and research guides, so make sure you write them in such a way that you will understand the content. Include examples and interesting slides and web-pages that you encounter during your research.

For this topic, you should research the following incidents, outlining the reasons how failed IT or failed communication (or both) contributed to the way the situation unfolded.

- The Therac-25 Incident
- The Mars Orbiter Incident
- USS Vincennes and the A320
- Black Monday

Exercise 2:

Prepare a short, five minute presentation on the results of your research for Exercise 1 above. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 3:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

1.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 2: Introductory UML modelling with StarUML

2.1 Learning Objectives

This topic provides an overview of using StarUML to build UML diagrams. On completion of the topic, you will be able to:

- Obtain and use the StarUML diagramming package;
- Develop class diagrams from fixed, simple scenarios.

2.2 Timings

Lectures:	1 hour
Laboratory Sessions:	3 hours
Private Study:	7.5 hours
Tutorial:	1 hour

2.3 Laboratory Sessions

The time allocation for the laboratory sessions for this topic is 3 hours.

Activity 1:

Consider the following scenarios. Identify potential classes, methods and attributes:

1. A library needs to keep track of its books, and which patrons have each of the books.
2. A university needs to keep track of its courses, and its students, and which students are registered to which course (and which courses have which students on them).
3. A shop needs to keep track of the stock it has on the shelves, and also the stock it has in the backroom.

Activity 2:

Start up StarUML. Use this to represent the class diagrams that derive from your analysis in Activity 1.

2.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the diagrams during the laboratory sessions, finish these during your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- StarUML user tutorials
- UML Class diagrams
- Other UML diagramming tools (such as Rational Rose)

Exercise 3:

Consider the following scenario. Identify candidate classes, methods and attributes and then draw the class diagram in StarUML.

A shipping firm has a fleet of ships of which they need to keep track. These ships are registered with a licence code, and classified according to their speed and storage capacity in tons. The firm has a number of contracts with businesses, and ships are assigned to these contracts on a day by day basis. Each of these contracts will have a duration and an amount of freight (in tons) that need to be shipped. A single ship might not be able to make the journey, and so multiple ships may be assigned where appropriate.

Exercise 4:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 5:

Review the lecture material and ensure that you are comfortable with everything discussed thus far

2.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Discussion of Private Study Exercise

Discuss as a group your solution to Exercise 3 in the private study.

Exercise 2: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 3: Object-Oriented Modelling

3.1 Learning Objectives

This topic provides an overview of object-oriented modelling. On completion of the topic, you will be able to:

- Define the benefits and drawbacks of OOAD;
- Make use of event decomposition;
- Build use case models.

3.2 Timings

Lectures:	2 hours
Laboratory Sessions:	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

3.3 Laboratory Session

The time allocation for the laboratory session for this topic is 2 hours.

Activity 1:

Work together in small groups of three or four.

Consider the following simple scenarios, and generate an appropriate list of candidate actions:

1. A web-based book shop (such as Amazon)
2. A web-based social networking site (such as Facebook or Orkut)
3. A desktop word processor

Activity 2:

Working alone, take the analysis of the scenarios above and create appropriate use case diagrams for each in StarUML.

3.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the diagrams from the seminar, finish these during your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- Use case diagrams
- SSADM
- Benefits of OOAD over structural modelling
- Drawbacks of OOAD over structural modelling

Exercise 3:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above that you will present during the tutorial session. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 4:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

3.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 4: Static Modelling in UML

4.1 Learning Objectives

This topic provides an overview of class diagrams and static modelling. On completion of the topic, you will be able to:

- Use Natural Language Analysis to identify candidate classes and methods;
- Design class diagrams;
- Implement class diagrams in code.

4.2 Timings

Lectures:	2 hours
Laboratory Sessions:	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

4.3 Laboratory Sessions

The time allocation for the laboratory sessions for this topic is 2 hours.

Activity 1:

Perform NLA on the following paragraph, and create the class diagram that follows from your analysis. You should go through the proper stages of the NLA process discussed in the lecture, including dealing with synonyms and redundancies, and inferring attributes, classes and operations from the information you have available.

The system that you are being asked to build is one of a web-based front-end to a hardware shop. The hardware shop contains many different kinds of tools such as hammers, screwdrivers and wrenches. The shop has a customer loyalty program and gives a discount to customers who have spent a certain amount of money over the past year. The software you write must also keep track of stock in the warehouse.

Once you have generated the class diagram, either write or generate the code that is implied by the diagram. Your program must be able to compile, but it does not have to do anything that is required of the program in the problem statement.

Activity 2:

Perform NLA on the following paragraph, and create the class diagram that follows from your analysis. You should go through the proper stages of the NLA process discussed in the lecture, including dealing with synonyms and redundancies, and inferring attributes, classes and operations from the information you have available.

The shop is called Charlotte's Web, and specialises in spider-themed jewellery that is sold from a retail outlet in the city's high street. The shop has a high degree of turnover and is looking to commission someone to develop a web-based store that customers can use. It should not be possible for people to buy jewellery directly from the web – all of our jewellery is custom made and all that customers should be able to do is book an appointment with one of our specialised spider jewellers. This is an exciting opportunity and we hope that you are as enthused about this task as we are!

Once you have generated the class diagram, either write or generate the code that is implied by the diagram. Your program must be able to compile, but it does not have to do anything that is required of the program in the problem statement.

4.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish these tasks during your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- Natural Language Analysis
- Implementing code from class diagrams
- Candidate classes in UML

Exercise 3:

Take the code that you obtained for Activity 1 in the laboratory session. Add in the following functionality, making a note in your journal when you had to add to your design in order to make it work. Make assumptions where required, but note these assumptions in your journal.

- Add a new type of tool that can be sold
- Adjust the quantity of tools in stock
- Allow a customer to buy some of the stock, honouring the discount offered by the loyalty program.

Exercise 4:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above that you will present during the tutorial session. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 5:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

4.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Discussion of Private Study Exercise

Discuss as a group your solution to Exercise 3 in the private study session.

Exercise 2: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 5: Dynamic Analysis and Design

5.1 Learning Objectives

This topic provides an overview of activity and sequence diagrams. On completion of the topic, you will be able to:

- Make use of activity diagrams;
- Turn activity diagrams into code;
- Develop sequence diagrams.

5.2 Timings

Lectures:	2 hours
Laboratory Sessions:	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

5.3 Laboratory Sessions

The time allocation for the laboratory sessions for this topic is 2 hours.

Activity 1:

This is a group exercise that involves playing a game of cards and then constructing the appropriate activity diagrams. Your group will consist of members who know how to play the game and others who do not. You should spend some time at the beginning of the session playing through the game, with an effort being made to focus on resolving the ambiguities and questions raised by those who are learning for the first time.

Activity 2:

Construct activity diagrams that represent the major processes of the game. If you are playing blackjack for example, you should construct activity diagrams that handle the dealing of the cards, the order of play, and the evaluation of winning conditions.

Activity 3:

Pass the diagrams you have constructed to another group. You will receive their instructions in return. Try to play the game as they have outlined in their diagrams, **interpreting the instructions exactly**. Do not attempt to fill in ambiguity or missing information from your own understanding – simply play the game according to the processes you have been given.

5.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

As part of your ongoing journal exercise, you should research the following topics:

- Sequence diagrams
- Activity diagrams

Exercise 2:

Research the rules of five card draw (a variant of poker), and develop a set of diagrams that show how a hand should be dealt out, and what a player must do in order to play their hand.

Exercise 3:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

5.5 Tutorial Notes

The tutorials for this topic will last for 1 hour. You can expect to spend some of this time discussing your answers to the Private Study exercises with your lecturer and other students. Your lecturer will then direct you on completing the tasks below.

Exercise 1: Poker Rules

In Private Study Exercise 2, you put together a set of diagrams that explain how to play a hand of poker. In groups of four, swap your diagrams and attempt to play a hand of poker using only the instructions you have been given.

Exercise 2: Refining Models

As a group, work together to refine the diagrams you have produced until a successful game of poker can actually be played.



Topic 6: OOAD Case Study

6.1 Learning Objectives

This topic provides an overview of previous content in context. On completion of the topic, you will be able to:

- Analyse a complex scenario;
- Design diagrams based on that scenario.

6.2 Timings

Lectures:	1 hour
Laboratory Sessions:	3 hours
Private Study:	7.5 hours
Tutorials:	1 hour

6.3 Laboratory Sessions

The time allocation for the laboratory sessions for this topic is 3 hours.

6.3.1 The Scenario

'Trucks for Hire' are a van and truck rental firm operating in a single city. The business was started several years ago, and has progressed to the point where expansion is a legitimate possibility. However, until now most of the administration of the business has been handled with paper files, post-it notes and conversations between staff members. The owner of the company knows that this is not sustainable, and has commissioned you to develop a piece of software that he can use to manage his organisation.

The company currently offers customers the opportunity to hire one of three kinds of vehicle – combo vans, transit vans, and box vans. When customers show up at the front desk, they must provide a valid driving licence and this determines which of the vans they can hire. Anyone can hire a combo van, anyone who has a driving licence that was issued before 1990 can drive a transit van, and for all other cases the appropriate driving licence credentials are required. The fee for the hire is based on the type of vehicle and the length of time that the individual is to have the vehicle. The company also offers extras, such as satellite navigation equipment and full insurance, but these are additional and not included in the standard price.

The company currently has ten of each of the vans, and customers can book ahead to reserve a vehicle on a particular day for a particular length of time.

For those customers who do not feel comfortable driving one of the vehicles themselves, the company will make available a driver on a per hour basis. However, they have only four drivers on the payroll and these can work a maximum of 40 hours in a week, and a maximum of two jobs a day, of which the sum can be no longer than eight hours (with an hour lunch break scheduled somewhere). Drivers are thus not always available, and customers are required to reserve their vehicle on a time and day when a driver is available. In addition to charging an hourly rate for the driver, the company also charges per mile, with the mileage of the hired vehicle being used in the calculations for the overall cost. The company provides an allowance of 40 miles (rural) or 10 miles (urban) per hour. Transporting a load 20 miles away through the city then is classed as a two hour journey. The maximum load that can be transported per journey is based on the capacity of the vehicle in question.

Your software must be able to handle all of this, and provide both a web-based interface for customers and a desktop application for staff. The owner would like as much of this to be automated as possible. As such your software should handle scheduling and allocation of drivers to jobs, as well as tracking which vehicles are available, when they are available, and which customers have made reservations.

Activity 1:

Review the Natural Language Analysis of the provided scenario.

Activity 2:

Review the selection of candidate classes from the NLA exercise you conducted.

Activity 3:

Review the class diagram that emerged from your Natural Language Analysis.

Activity 4:

Review the use case diagram that you developed from the scenario.

Activity 5:

Review the activity diagrams that you developed from the scenario.

6.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish these tasks during your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

The worked example in the seminar and lecture did not fully explore the scenario. In your own time, work up activity diagrams for the following processes:

- Logging In
- Identifying if any vehicles are free on a specific date
- Identifying if any drivers are free on a specific date
- Registering a booking

Exercise 3:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

6.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Overview of Scenario Solution

Discuss as a class the solution to the exercise that your lecturer will provide.

Exercise 2: Reporting Back to the Class

As a result of the work you will have done for your private study, you should have activity diagrams for each of the four processes listed. Be prepared to discuss your diagrams with others in your class, and to help your peers refine and correct the diagrams they have themselves developed.



Topic 7: Design Patterns 1

7.1 Learning Objectives

This topic provides an overview of creational design patterns. On completion of the topic, you will be able to:

- Understand the use of design patterns;
- Design and use factory design patterns;
- Design and use abstract factory design patterns.

7.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

7.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1:

Consider the factory and abstract factory patterns you encountered during the lecture. Draw the class diagram for a factory that supports a bank account system containing three kinds of account. Each customer in the bank should have an account, and the bank should be able to track a number of these at the same time.

The following account types should be supported:

- A High interest account which has a 10% interest rate provided no withdrawals are made. If a withdrawal is made, the interest rate is reduced to 2% for a month.
- A current account with a 3% interest rate but no penalties on withdrawals.
- An investment account which allows deposits only, with a 15% interest rate.

Activity 2:

Write the code for your factory as outlined above. You should write a main program that incorporates at least two accounts of each type, and sets them up with random starting values. The program should allow you to withdraw and deposit from any account. Your front end should also include a way for the user to move the date onwards a month and apply all interest on accounts.

7.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish these tasks during your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- Design patterns
- Applications of the factory design pattern
- Applications of the abstract factory design pattern

Exercise 3:

Making use of the factory that you developed during the laboratory session, expand this to incorporate code to handle an overdraft limit, and an abstract factory that allows you to generate accounts for particular banks. You should have two banks, and they should both have a different overdraft limit.

Exercise 4:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 5:

Review the lecture material and ensure that you are comfortable with everything discussed thus far

7.5 Tutorial Notes

The tutorials for this topic will last for 1 hour. You can expect to spend some of this time discussing your answers to the Private Study exercises with your lecturer and other students. Your lecturer will then direct you on completing the tasks below.

Exercise 1: Abstract Factory

Discuss as a class the solution to the abstract factory exercise outlined as Exercise 3 in your private study session.

Exercise 2: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 8: Design Patterns 2

8.1 Learning Objectives

This topic provides an overview of the MVC, the Facade, the Strategy and the Flyweight. On completion of the topic, you will be able to:

- Make use of the Model-View-Controller design pattern;
- Make use of the facade design pattern;
- Make use of the strategy design pattern;
- Make use of the flyweight design pattern.

8.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

8.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1:

Making use of the flyweight pattern, create a program that handles customers ordering things from a restaurant. The restaurant should have a menu of four starters, four main courses and four desserts as well as four drinks. Each menu item should have a description and a price. Each customer should have a list of their ordered items stored, and a mechanism by which the total price can be calculated.

8.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish these tasks during your private study time.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- The singleton design pattern
- The chain of responsibility design pattern
- The memento design pattern
- The composite design pattern

Exercise 3:

Implement a facade class for the flyweight program you developed in the laboratory session. This facade should hide the implementation of the flyweight, and provide methods for adding menus, adding orders, and querying the price of an order.

Exercise 4:

Implement the facade class you developed for Exercise 3 as a singleton.

Exercise 5:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

8.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Facade

Discuss as a class your solutions to Exercise 3 from the private study session.

Exercise 2: Singleton

Discuss as a class your solutions to Exercise 4 from the private study session.



Topic 9: Elements of Good Design

9.1 Learning Objectives

This topic provides an overview of assessing the quality of software. On completion of the topic, you will be able to:

- Analyse and assess the quality of software;
- Assess the architectural quality of an object-oriented program;
- Make use of the observer data pattern to reduce coupling.

9.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

9.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1:

Create a benchmarking harness, and benchmark the following operations:

- Appending the word “blue” to a string 100, 1000, and 10000 times
 - First using a string and the append operation
 - Secondly using a StringBuffer
- Calculating the Fibonacci number at positions 10, 20, 30, 40 and 50 in the sequence.
 - Firstly using a loop within a function
 - Secondly using recursion
 - Thirdly using recursion and a cache

Activity 2:

Suggest three ways in which the following function can be optimised. Perform a benchmark for each way in isolation, and then on the function with all your optimisations incorporated:

```
public void doTheThings() {
    int[] sizes = {10, 20, 30, 40, 50, 60, 70, 80, 90, 100};
    double circumference, half, doub, quart, four;
    for (int i = 0; i < sizes.length; i++) {
        for (int j = 0; j < 1000; j++) {
            circumference = Math.PI * sizes[i];
            doub = Math.PI * sizes[i] * 2;
            four = Math.PI * sizes[i] * 4;
            half = (Math.PI * sizes[i]) / 2;
            quart = (Math.PI * sizes[i]) / 4;

            System.out.println ("Stats for Circle " + j + ": "
                + quart + ", " + half + ", " + circumference + ", "
                + doub + ", " + four);
        }
    }
}
```


9.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish the tasks during your private study time.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- Additional software quality attributes
- Benchmarking
- Test Driven Development
- Coupling and Cohesion

Exercise 3:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 4:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

9.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 10: Redesign and Implementation

10.1 Learning Objectives

This topic provides an overview of applying software quality attributes to design. On completion of the topic, you will be able to:

- Follow through the process of applying design patterns;
- Implement a solution from a design.

10.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

10.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1:

Using the case study discussed in the lecture, implement the observer structure required for the link between the model and the view/controller. Consider what information is likely to be needed by the view/controller classes and define a method in your interface for each of these.

Activity 2:

Using the case study discussed in the lecture, implement the Payroll, Staff, Owner and Driver classes with appropriate methods and attributes.

10.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the code from the lab session, finish this in your private study time. Remember that the tool you need is open source and can be freely downloaded.

Exercise 2:

You will previously have worked up diagrams for the implementation of several workflows. This was done as part of the private study for Topic 6. Assess these for validity, coupling and cohesion, and the suitability of design patterns, and then implement them along with your implementations from the laboratory session.

Exercise 3:

Review the lecture material and ensure that you are comfortable with everything discussed thus far

10.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Discuss Designs

Discuss as a class your reviews of the work you did for Exercise 2 in the private study session.

Exercise 2: Reporting Back to the Class

As a result of the work you will have done during private study, you should have code implementations for each of the workflows you designed in Topic 6. Be prepared to discuss your implementations with others in your class, and to help your peers refine and correct the code they have themselves developed.



Topic 11: Maintenance and Refactoring

11.1 Learning Objectives

This topic provides an overview of maintenance and refactoring. On completion of the topic, you will be able to:

- Identify different categories of maintenance activity;
- Identify the need for refactoring;
- Refactor methods and classes.

11.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

11.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1:

Go back over code you have written for this module. Profile each of your functions for 'bad smells' and refactor them accordingly.

11.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic. You should use this time to complete the exercises below as directed by your lecturer and to review the contents of this topic.

Exercise 1:

If you did not complete the work from the practical session, finish this in your private study time.

Exercise 2:

As part of your ongoing journal exercise, you should research the following topics:

- Bad code smells
- Common refactoring tasks
- Maintenance processes

Exercise 3:

Prepare a short, five minute presentation on the results of your research for Exercise 2 above. If you have found out anything particularly interesting, you should focus on that as a priority.

Exercise 4:

Review the lecture material and ensure that you are comfortable with everything discussed thus far.

11.5 Tutorial Notes

The tutorials for this topic will last for 1 hour..

Exercise 1: Reporting Back to the Class

As a result of the research you did during your private study time, you should have a short five minute presentation ready to give to the rest of the class. There is no need for this to be especially formal - you are simply reporting on anything interesting that you found during your research, or pointing out especially useful resources on the topic. Bring your journal along to the class so that you can make a note of anything especially useful that your classmates mention. This is a knowledge dissemination exercise; you are not being formally assessed on the style or content of the presentation.



Topic 12: Recap of Module

12.1 Learning Objectives

This topic provides an overview of module content. On completion of the topic, you will be able to:

- Explain what was covered during the module.

12.2 Timings

Lectures:	2 hours
Laboratory Sessions	2 hours
Private Study:	7.5 hours
Tutorials:	1 hour

12.3 Laboratory Sessions

The laboratory time allocation for this topic is 2 hours.

Activity 1

Provide a paragraph of explanation and explanatory code snippets and diagrams (where appropriate) for the following concepts. This represents a condensing of both module content and your journal entries into a form suitable for revision and later reference:

- Refactoring
- Coupling
- Cohesion
- Analysis
- Design
- Design Pattern
- Candidate Class
- Class Diagram
- Activity Diagram
- Sequence Diagram
- Singleton Design Pattern
- Facade Design Pattern
- Strategy Design Pattern
- Refactoring
- Maintenance

12.4 Private Study Exercises

You should spend approximately 7.5 hours on the Private Study for this topic.

Exercise 1:

If you did not complete the laboratory activity during the allotted time, complete it now.

Exercise 2:

Review the lecture material and your revision notes from Activity 1 in the laboratory session and ensure that you are comfortable with everything discussed thus far. If there are topics that you are not entirely sure of, make a note of them so they can be discussed during the tutorial.

12.5 Tutorial Notes

The tutorials for this topic will last for 1 hour.

Exercise 1: Report back to class

As a class exercise, you should discuss the revision topics that you constructed during the laboratory exercise.

Exercise 2: Revision

As a result of your reviewing in your private study, you may have come up with revision questions to discuss in class. Raise them now with your lecturer.