School of Information and Physical Sciences

COMP6290: Compiler Design
Callaghan
Semester 2 - 2023

OVERVIEW

Course Description

Compiler Design will teach students the fundamental concepts and techniques used for building a simple compiler. Focusing on both theory and practice, we will use a sample language to explore the lexical, syntactic and semantic structures of programming languages, and learn to use those structures in implementing a demonstrative compiler. The discussion will also include the examination of intermediate code states, machine code optimisation techniques and support for advanced language features. At the end of the course, students will understand different considerations and phases of compilation, the impact of language attributes upon the compilation process, the effect of hardware feature on the generated code and the practical fundamentals of compiler implementation.

Requisites

This course has similarities to COMP3290. If you have successfully completed COMP3290 you cannot enrol in this course.

Assumed Knowledge
SENG6120

Contact Hours
Callaghan
Lecture
Face to Face On Campus
2 hour(s) per Week for Full Term

Workshop
Face to Face On Campus
2 hour(s) per Week for 12 Weeks starting Week 2

Unit Weighting
10

Workload
Students are required to spend on average 120-140 hours of effort (contact and non-contact) including assessments per 10 unit course.

CONTACTS

Course Coordinator	**Callaghan** Dr Nasimul Noman Nasimul.Noman@newcastle.edu.au (02) 4042 0488 Consultation: Tuesday 12:00~14:00 (preferably via prior appointment)
Teaching Staff	Dr Nasimul Noman Phone: (02) 4042 0488 Email: Nasimul.Noman@newcastle.edu.au Office: ES237 Mr. Daniel Bell Email: daniel.p.bell@newcastle.edu.au
School Office	**School of Information and Physical Sciences** SR233, Social Sciences Building Callaghan CESE-SIPS-Admin@newcastle.edu.au +61 2 4921 5513 9am-5pm (Mon-Fri)

SYLLABUS

Course Content	1. Introduction to the theory of grammars 2. High level languages and their compilers 3. Lexical analysis 4. Syntactic analysis 5. Semantic analysis 6. Object code generation 7. Optimisation 8. Compiling Advanced Language Features
Course Learning Outcomes	**On successful completion of this course, students will be able to:** 1. Specify and analyse the lexical, syntactic and semantic structures of advanced language features 2. Separate the lexical, syntactic and semantic analysis into meaningful phases for a compiler to undertake language translation 3. Write a scanner, parser, and semantic analyser without the aid of automatic generators 4. Turn fully processed source code for a novel language into machine code for a novel computer 5. Describe techniques for intermediate code and machine code optimisation 6. Design the structures and support required for compiling advanced language features.
Course Materials	**Lecture Materials:** - Lecture Slides will be released on the Canvas site.

Other Resources:
- Project Source Language Specifications, Project Target Machine Architecture Specifications, and Assessment Specifications for each part of the project will be released in the relevant section in Canvas

Required Reading:
Compilers: Principles, Techniques, and Tools,
2nd Edition
- Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman

COMPULSORY REQUIREMENTS

In order to pass this course, each student must complete ALL of the following compulsory requirements:

Contact Hour Requirements:
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Course Assessment Requirements:
- Assessment 2 - Formal Examination: Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course. Students whose overall mark in the course is 50% or more, but who score less than 40% in the compulsory item and thus fail to demonstrate the required proficiency, will be awarded a Criterion Fail grade, which will show as FF on their formal transcript. However, students in this position who have scored at least 25% in the compulsory assessment item will be allowed to undertake a supplementary 'capped' assessment in which they can score at most 50% of the possible mark for that item.

Pre-Placement Requirements:
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SCHEDULE

Week	Week Begins	Topic	Learning Activity	Assessment Due
1	17 Jul	Introduction to Compiler Design	No Workshop in Week 1.	
2	24 Jul	CD Programming Language	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
3	31 Jul	Lexical Analysis	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
4	7 Aug	Syntax Analysis	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	Project Part 1 - Programming in CD and Scanner - 11/08/2023 (Friday)
5	14 Aug	Top-Down Parsing	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
6	21 Aug	Symbol Table and Error Recovery	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
7	28 Aug	Bottom-Up Parsing	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
8	4 Sep	Semantic Analysis	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	Project Part 2 - Parser and Symbol Table - 08/09/2023 (Friday)
9	11 Sep	Run-Time Environment: The Stack Machine (SM)	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	

10	18 Sep	Code Generation	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
		Mid Term Break		
		Mid Term Break		
11	9 Oct	Code Optimisation	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	
12	16 Oct	Revision	Workshop to discuss the project and review examples related to the lecture material from the previous lectures	Project Parts 3 – Semantic Analyser and Code Generator & Written Assignment & Report - 20/10/2023 (Friday)
13	23 Oct	Extra revision (if needed)	Revision & Review.	
		Examination Period		
		Examination Period		

ASSESSMENTS

This course has 3 assessments. Each assessment is described in more detail in the sections below.

	Assessment Name	Due Date	Involvement	Weighting	Learning Outcomes
1	Essays/Written Assignment	Week 12 (20/10/2023)	Individual	10%	1, 3
2	Formal exam*	As per Final Exam Timetable.	Individual	50%	1, 2, 3, 4, 5, 6
3	Projects	Week 4 (11/08/2023), Week 8 (08/09/2023) and Week 12 (20/10/2023) for the different phases of the compiler. Check Canvas for details.	Group	40%	1, 2, 3, 4, 5

* This assessment has a compulsory requirement.

Late Submissions   The mark for an assessment item submitted after the designated time on the due date, without an approved extension of time, will be reduced by 10% of the possible maximum mark for that assessment item for each day or part day that the assessment item is late. Note: this applies equally to week and weekend days.

Assessment 1 - Essays/Written Assignment

Assessment Type	Written Assignment
Purpose	To assess the ability of the students to analyse the advanced topics in compilation and critically assess those methods.
Description	To be announced in Canvas.
Weighting	10%
Due Date	Week 12 (20/10/2023)
Submission Method	Specific Location In-person or via email.
Assessment Criteria	Correctness and completeness
Return Method	Online
Feedback Provided	Returned Work - .

Assessment 2 - Formal exam

Assessment Type	Formal Examination
Purpose	The final formal exam is designed to test the individual student's theoretical knowledge of the course material and their ability to describe, analyse and comprehend this material. The final exam will be used as a comprehensive evaluation of course learning outcomes.
Description	
Weighting	50%
Compulsory Requirements	Minimum Grade / Mark Requirement - Students must obtain a specified minimum grade / mark in this assessment item to pass the course.
Due Date	As per Final Exam Timetable.
Submission Method	Formal Exam
	Materials permitted in the Formal Exam:
	1. A4 double sided sheet of handwritten or typed notes (Memory Aid sheet)
	2. Any non-programmable calculators are permitted
Assessment Criteria	Correctness and completeness of answers.
Return Method	Not Returned
Feedback Provided	No Feedback - .
Opportunity to Reattempt	Students WILL be given the opportunity to reattempt this assessment. Refer to course outline for details.

Assessment 3 - Projects

Assessment Type	Project
Purpose	Implement a complete compiler consisting of its major modules or phases.
Description	A new language (CD) is to be compiled for a new architecture (SM). Includes a Scanner, Parser, Semantic Analyser and Code Generator. There will be scope for including various features of Code Optimisation. To be completed in a group of two.
Weighting	40%
Due Date	Week 4 (11/08/2023), Week 8 (08/09/2023) and Week 12 (20/10/2023) for the different phases of the compiler. Check Canvas for details.
Submission Method	Online
Assessment Criteria	Correctness of running compiler code and SM code.
Return Method	Online
Feedback Provided	Online - Up to 3 weeks after submission. Constructs not implemented properly.

ADDITIONAL INFORMATION

Grading Scheme

This course is graded as follows:

Range of Marks	Grade	Description
85-100	High Distinction (HD)	Outstanding standard indicating comprehensive knowledge and understanding of the relevant materials; demonstration of an outstanding level of academic achievement; mastery of skills*; and achievement of all assessment objectives.
75-84	Distinction (D)	Excellent standard indicating a very high level of knowledge and understanding of the relevant materials; demonstration of a very high level of academic ability; sound development of skills*; and achievement of all assessment objectives.
65-74	Credit (C)	Good standard indicating a high level of knowledge and understanding of the relevant materials; demonstration of a high level of academic achievement; reasonable development of skills*; and achievement of all learning outcomes.
50-64	Pass (P)	Satisfactory standard indicating an adequate knowledge and understanding of the relevant materials; demonstration of an adequate level of academic achievement; satisfactory development of skills*; and achievement of all learning outcomes.
0-49	Fail (FF)	Failure to satisfactorily achieve learning outcomes. If all compulsory course components are not completed the mark will be zero. A fail grade may also be awarded following

		disciplinary action.

*Skills are those identified for the purposes of assessment task(s).

Communication Methods

Communication methods used in this course include:
- Canvas Course Site: Students will receive communications via the posting of content or announcements on the Canvas course site.
- Email: Students will receive communications via their student email account.
- Face to Face: Communication will be provided via face to face meetings or supervision.

Course Evaluation

Each year feedback is sought from students and other stakeholders about the courses offered in the University for the purposes of identifying areas of excellence and potential improvement.
As a result of student feedback, the following changes have been made to this offering of the course:
- The project involvement has been changed from individual to pair.

Oral Interviews (Vivas)

As part of the evaluation process of any assessment item in this course an oral examination (viva) may be conducted. The purpose of the oral examination is to verify the authorship of the material submitted in response to the assessment task. The oral examination will be conducted in accordance with the principles set out in the Oral Examination (viva) Procedure. In cases where the oral examination reveals the assessment item may not be the student's own work the case will be dealt with under the Student Conduct Rule.

Academic Misconduct

All students are required to meet the academic integrity standards of the University. These standards reinforce the importance of integrity and honesty in an academic environment. Academic Integrity policies apply to all students of the University in all modes of study and in all locations. For the Student Academic Integrity Policy, refer to https://policies.newcastle.edu.au/document/view-current.php?id=35.

Adverse Circumstances

The University acknowledges the right of students to seek consideration for the impact of allowable adverse circumstances that may affect their performance in assessment item(s). Applications for special consideration due to adverse circumstances will be made using the online Adverse Circumstances system where:
1. the assessment item is a major assessment item; or
2. the assessment item is a minor assessment item and the Course Co-ordinator has specified in the Course Outline that students may apply the online Adverse Circumstances system;
3. you are requesting a change of placement; or
4. the course has a compulsory attendance requirement.
Before applying you must refer to the Adverse Circumstance Affecting Assessment Items Procedure available at:
https://policies.newcastle.edu.au/document/view-current.php?id=236

Important Policy Information

The Help button in the Canvas Navigation menu contains helpful information for using the Learning Management System. Students should familiarise themselves with the policies and procedures at https://www.newcastle.edu.au/current-students/no-room-for/policies-and-procedures that support a safe and respectful environment at the University.

Other Information

This course makes extensive use of Problem Based Learning. It is very difficult for students to perform to their ability if they do not attend lectures and workshops regularly.

Canvas will contain the latest version of project specifications.

Canvas Discussion Board is a major tool for discussing project problems and disseminating answers to questions raised.

The schedule /content of the lecture may change to keep up with the progress of the course