# **EECS4302:** Compilers and Interpreters Section A – Fall 2022

#### LAST UPDATED: SEPTEMBER 8, 2022

SUBJECT TO CHANGES UNTIL: SEPTEMBER 20, 2022

# COURSE SYLLABUS

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### 1 <u>COURSE POLICIES</u>

To ensure a smooth, fair, and effective in-person delivery of this course:

1. **Team Work Encouraged for Labs**/Assignments: You will be able to gain <u>full</u> marks for all labs <u>as long as</u> submission attempts are made by the corresponding submission deadlines.

Your submitted labs, though awarded <u>full</u> marks automatically, will still be graded and given detailed feedback (i.e., compilation and testing results). The grading results and feedback are intended to exemplify how the actual programming tests will be graded. Therefore, it would be your best interest in submitting work representing your <u>true</u> and <u>best</u> attempt.

The rationales of this policy are that: 1) you can rest assured that you will <u>not</u> lose any marks from labs (as long as you submit them by the deadlines); and 2) you can just focus on the learning by seeking help from colleagues, TAs, and Jackie without worrying about violating the academic honesty policy.

Please do not abuse this policy: you are still 100% responsible for acquiring the intended understandings and skills from these labs. Be advised that later scheduled (written and programming) tests will be based on these labs, so if you chose <u>not</u> to learn the materials responsibly (e.g., relying much on your colleagues, submitting incomplete work and only intending to look at solutions when they are made available), you risk <u>poor performance</u> in subsequent tests and the exam.

- 2. No Team Work Allowed for Scheduled Tests : All written & programming tests are to be completed individually (i.e., team work is forbidden).
- 3. **Plagiarism**: When submitting each of your <u>written</u> tests and <u>programming</u> tests, you claim that it is solely your work. It is considered as an violation of academic integrity if you copy or share any parts of your work (e.g., code, notes) during any stage of your development. The instructor and TAs may examine all submissions, and suspicious ones will be reported *immediately* to Lassonde as a breach of academic integrity. We do not tolerate academic dishonesty, so please be fully responsible for your learning.
- 4. MEETING LAB/TEST DEADLINES : Stringent deadlines are imposed on <u>all</u> scheduled <u>written</u> tests (to be completed and submitted via eClass), as well as scheduled <u>programming</u> tests and labs (to be submitted via the *web submit* to the EECS server). An in-person exam will be scheduled by the registrar office to take place during the exam period. It is your responsibility for meeting all deadlines.
- 5. **LATE ENROLMENT**: Students who are not yet officially registered should <u>assume</u> an eventual successful enrolment into the course and are responsible for: 1) contacting the section instructor <u>within Week 1</u> for course information (e.g., lecture materials, lab assignments access and deadlines); and 2) attending lectures, submitting lab assignments, and taking scheduled tests in time.

No lab deadline extensions or deferred tests will be accommodated.

#### 2 INSTRUCTOR

- Chen-Wei (JACKIE) Wang
  - Contact: jackie@eecs.yorku.ca (https://www.eecs.yorku.ca/~jackie/)
  - <u>In-Person</u> Office Hours: 12:30 13:30 (EST), Tue & Thu; or by Appointments.
     Campus Office: Lassonde Building, Room 2043 [19, D5 in the Keele campus]
  - <u>Zoom</u> Office Hours: 16:00 17:00 (EST), Mon & Wed; or by Appointments. Virtual Office: https://yorku.zoom.us/my/jackie.loves.oxford

#### 3 <u>VENUES</u>

– In-Class Lectures

14:30 – 16:00, Tuesdays & Thursdays R S129 (Ross Building South)

 $\left[ \ \mathrm{D5}/\mathrm{28} \ \mathrm{on} \ \mathrm{the} \ \mathrm{Keele} \ \mathrm{Campus} \ \mathrm{Map} \ \right]$ 

#### 4 <u>ECLASS SITE</u>

- There is an eClass site for Section A: https://eclass.yorku.ca/course/view.php?id=64630

## 5 <u>Study Materials</u>

- There will be no textbooks for this course. Study your instructor's lecture materials:
  - The lectures page: https://www.eecs.yorku.ca/~jackie/teaching/lectures/index.html#EECS4302\_F22
- If you wish to review OOP in Java, consider the study materials for:
  - EECS2030 (Introductory OOP): https://www.eecs.yorku.ca/~jackie/teaching/lectures/index.html#EECS1022\_W21
  - EECS2030 (Advanced OOP): https://www.eecs.yorku.ca/~jackie/teaching/lectures/index.html#EECS2030\_F21
  - EECS2011 (Data Structures): https://www.eecs.yorku.ca/~jackie/teaching/lectures/index.html#EECS2011\_W22
- Here are some optional reference textbooks:
  - TITLE: Engineering a Compiler AUTHOR: Keith D. Cooper & Linda Torczon PUBLISHER: Morgan Kaufmann Publishers Inc. EDITION: Second Edition (2012) ISBN: 978-0-12-088478-0
  - Classic Text (the "dragon" book): TITLE: Compilers: Principles, Techniques, and Tools AUTHOR: Alfred V. Aho, Monica S. Lam, Ravi Sethi & Jeffery D. Ullman PUBLISHER: Addison-Wesley Longman Publishing Co., Inc. EDITION: Second Edition (2006) ISBN: 978-0-321-48681-3

#### 6 PREREQUISITES

- General Prerequisites: A cumulative grade point average (GPA) of 4.50 or better over all previously completed Major EECS courses. The GPA computation excludes all EECS courses that have a second digit 5, or are Co-Op/PEP courses.
- LE/EECS2001 3.00; LE/EECS2011 3.00

# 7 <u>Course Description</u>

This course covers principles and design techniques for compilers and interpreters, purpose and design of domain-specific languages (DSLs), compiler organization, compiler writing tools, scanning, parsing, semantic analysis, code generation, and if time permitted, run-time storage organization, memory management, and optimization.

This course is a hands-on introduction to the design and construction of compilers and interpreters. The main purpose is to have students acquire the techniques of defining their own languages and implementing tools to suit their own needs. At the end of the course, students will understand the architecture of compilers and interpreters, their major components, how the components interact, and the algorithms and tools that can be used to construct the components.

Students will be assigned a semester-long project divided into phases: e.g., designing the grammar of a domain-specific language, using tools to generate its scanners and parsers, and applying suitable software design patterns (e.g., composite, visitor) to build abstract syntax trees (ASTs) of input programs and to perform semantic operations (e.g., evaluation, type checking, code generations). Generated programs may take different forms: e.g., C code, database schemas/procedures, theorems/functions to a proof assistant, specification language to a model checker.

### 8 <u>COURSE LEARNING OUTCOMES (CLOS)</u>

Upon completion of the course, students are expected to be able to:

**CLO1** Compare and contrast General-Purpose Languages (GPLs) and Domain-Specific Languages (DSLs).

**CLO2** Apply the theoretical understanding of, and use the relevant tools to generate, a lexical scanner.

**CLO3** Apply the theoretical understanding of, and use the relevant tools to generate, a grammatical parser.

CLO4 Construct an abstract syntax tree & perform semantic operations on it.

CLO5 Communicate the design and implementation of a DSL and its associated tools.

## 9 GRADING SCHEME

3 Assignments (3% each)	9%
Project	18%
Programming Test	8%
5 In-Class Quizzes (4% each)	20%
Final Exam	45%

## 10 MAPPING RAW MARKS TO LETTER GRADES

According to the Common Grading Scheme for Undergraduate Faculties approved by Senate:

Letter Grade	Range of Marks	Interpretation	
A+	$\geq 90$	Exceptional	
А	$\geq 80$	Excellent	
B+	$\geq 75$	Very Good	
В	$\geq 70$	Good	
C+	$\geq 65$	Competent	
С	$\geq 60$	Fairly Competent	
D+	$\geq 55$	Passing	
D	$\geq 50$	Marginally Passing	
Е	$\geq 45$	Marginally Failing	
F	$\geq 40$	Failing	

- For each grading unit, you will receive a **raw mark score** (not necessarily out of 100).

The <u>weighted sum</u> of all grading units will be mapped to its letter grade.
 e.g., Say there are only two grading units: Exam (60%) and Lab1 (40%).

Receiving 150 marks (out of 200) for Exam and 2 marks (out of 3) for Lab1 leads to a letter grade B (based on the weighted sum  $\frac{150}{200} \times 60 + \frac{2}{3} \times 40 \approx 71.7$ ).

#### 11 EXPECTED WEEKLY WORKLOAD

- Lassonde's recommendation is 3 4.5 hours per credit: 9 13.5 hours for a 3.00 course.
- "In-Class" Hours:
  - Weekly Lectures <u>Optional</u>: Office Hours
- "Out-of-Class" Hours:
  - Completing Assignments, Studying for Lectures/Tests [6 to 10.5 hours]
- You may find yourself needing more time to digest the materials and build the skills.
   The harder you work, the easier you may find in your future career endeavours.

#### 12 ATTENDANCE OF CLASSES: ENCOURAGED & REWARDING

- There are 23 upcoming in-class lectures in total (2 classes  $\times$  12 weeks first class).
- Attending classes (in-time & focused) is an **indispensable** part of your learning.
- Despite it being your responsibility, Jackie would encourage you to attend classes by the following rewarding scheme:
  - Attendance will be taken <u>randomly</u> (via iClicker) on X classes  $(12 \le X \le 23)$  $\Rightarrow$  Attendance will be checked somewhere between <u>every class</u> and <u>every other class</u>.
  - Each attendance will be checked briefly (e.g., for a few minutes) at sometime between 10 minutes after class <u>starts</u> and 10 minutes before class <u>ends</u>.
     ⇒ Please always have the iClicker launched on your computer or mobile device.
  - At the end of the semester, say you attended Y classes:

if	$Y < \lfloor 50\% \cdot X \rfloor$	$\rightarrow$	no bonus
elseif	$Y \geq \lfloor 50\% \cdot X \rfloor$	$\rightarrow$	.5% bonus
elseif	$Y \geq \lfloor 60\% \cdot X \rfloor$	$\rightarrow$	1% bonus
elseif	$Y \ge \lfloor 70\% \cdot X \rfloor$	$\rightarrow$	2% bonus
elseif	$Y \geq \lfloor 80\% \cdot X \rfloor$	$\rightarrow$	4% bonus
elseif	$Y \geq \lfloor 90\% \cdot X \rfloor$	$\rightarrow$	5% bonus

 $[\approx 3 \text{ hours }]$ 

• For examples:

```
X = 23 (check at every class) X = 12 (check at every other class)
```

if $Y < 11 \rightarrow$  no bonusif $Y < 6 \rightarrow$  no bonuselseif $Y \ge 11 \rightarrow .5\%$  bonuselseif $Y \ge 6 \rightarrow .5\%$  bonuselseif $Y \ge 13 \rightarrow .1\%$  bonuselseif $Y \ge 7 \rightarrow .1\%$  bonuselseif $Y \ge 16 \rightarrow .2\%$  bonuselseif $Y \ge 8 \rightarrow .2\%$  bonuselseif $Y \ge 18 \rightarrow .4\%$  bonuselseif $Y \ge 9 \rightarrow .4\%$  bonuselseif $Y \ge 10 \rightarrow .5\%$  bonuselseif $Y \ge 10 \rightarrow .5\%$  bonus

- The above rewarding scheme  $\underline{\mathbf{only}}$  applies to in-class lectures,  $\underline{\mathbf{not}}$  lab sessions.
- The allowable quota for you to miss classes, so as to get a particular bonus, already accommodates for valid excuses (e.g., sick, family emergency).

Therefore,  $\underline{\mathbf{no}}$  excuses will be considered for missing classes.

- The instructor reserves the right to <u>cancel</u> your bonus if you attend classes but cause distractions (e.g., talking, using devices for irrelevant activities) to the instructor and/or to other students.
- What should I do to set up the iClicker for attendance checks?
  - Please refer to this starter guide (to install iClicker on your mobile device):

https://lthelp.yorku.ca/polling-students/

iclicker-student-app-quick-start-guide

When creating an iClicker account, please be sure to supply your student number.

- Ignore the first section "For Courses using eClass integration".
- Follow these sections:
  - \* "For Courses <u>not</u> using eClass integration"
  - \* "Add Your Instructor iClicker Course":

Search for "LE/EECS4302 (Section A, F'22) - Compilers and Interpreters".

- \* "Respond to Polls"
- When launching iClicker, it is critical that you allow iClicker to use your location; otherwise you will not be able to join the course and take attendance.



# 13 <u>Semester Calendar</u>

Figure 1 summarizes the schedule of required work items:

- Attend the scheduled in-class lectures on Tuesdays and Thursdays (14:30 to 16:00).
- Each **in-class** <u>written quiz</u>, if scheduled, starts at 14:35 and lasts for  $\approx 20$  minutes.
- <u>Note</u>. Specific details for each quiz will be announced in advance.
- An in-lab programming test will be held on Saturday, October 29 (2 weeks before the drop deadline).
  - The exact time of the test will be surveyed to suit the schedule of most (if not all).
    - The test will last for  $\approx 80$  minutes.

MON       TUE       WED       THU       FRI       SAT         SEP       5       6       7       8       9         Week 1       12       13       14       15       16         Week 2       12       13       14       15       16         Week 3       19       20       21       22       23         Week 4       Lecture 3       14       15       16         Week 3       Release: A1       26       27       28       29       30         Week 4       Ouiz 1       12       13       14       14       14         Week 5       OCT       3       4       5       6       7         Week 5       OCT       3       4       5       6       7         Week 6       17       18       19       20       21       4         Week 7       Release: A3       Quiz 2       26       27       28       29         Week 7       Release: A3       Quiz 2       14       4       4         Week 7       Release: A3		EECS4302 Co	ompilers and I	nterpreters (	Section A, Fal	l 2022) - Sem	ester Calenda	ir	
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Project		14	Lecture 16	16	Lecture 17	18			Project
Week 10 Quiz 4	Week 10		Quiz 4	10	1/	10			
Lecture 18 Lecture 19			Lecture 18		Lecture 19				
21 22 23 24 25 Week 11	Week 11	21	22	23	24	25			
Lecture 20 Lecture 21	Week II		Lecture 20		Lecture 21				
28 29 30 DEC 1 2		28	29	30	DEC 1	2			
Week 12 Quiz 5	Week 12		Quiz 5		Locture 22				
		5	Lecture 22	.7	Lecture 23			_	
Week 13 Due: Project Lecture 24 Study Day Exam (December 8 to December 23)	Week 13	Due: Project	Lecture 24	Study Day	Exam	) (December 8	3 to Decembe	r 23)	

Figure 1: EECS4302-A F22 Semester Calendar – Expected Work Items

### 14 COVERAGE OF QUIZZES

Tentatively, referencing the semester calendar in Figure 1 (p8):

- Quiz 1 covers Lectures 1-5
- Quiz 2 covers Lectures 6 9
- Quiz 3 covers Lectures 10 13
- Quiz 4 covers Lectures 14 17
- Quiz 5 covers Lectures 18 21
- Programming Test covers A1 A3 and ANTLR4 tutorial

## 15 WEEKLY SCHEDULE

In the time table below, each cell denotes a 30-minutes interval.

- Cell 8:30 denotes the interval starting at 8:30 and ending at 9:00.
- For example, the in-person office hours (on Tuesdays and Thursdays) occupies 2 cells indicates that it lasts for 1 hour (starting at 12:30 and ending at 13:30).

	Monday	Tuesday	Wednesday	Thursday	Friday
8:30					
9:00					
9:30					
10:00					
10:30					
11:00					
11:30					
12:00					
12:30		Office Hours		Office Hours	
13:00		(In-Person)		(In-Person)	
13:30					
14:00					
14:30		FECS4302-A		FECS4302-A	
15:00		Lecture R S129		Lecture R S129	
15:30					
16:00	Office Hours		Office Hours		
16:30	(Zoom)		(Zoom)		
17.00					

# 16 (TENTATIVE) TOPICS TO BE COVERED

- Overview of Compilation
- Lexical Analysis (Scanners)
- Syntax Analysis (Parsers)
- Use of a Parser Generator (ANTLR)
- OOP Design Patterns: Composite & Visitor
- Context-Sensitive Analysis
- Intermediate Representation
- Optimization