Programming Languages
CS 331 – Spring 2021
Credits: 3 hours
*** This is an online synchronous course ***

Instructor: David Furcy

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Office Hours: MWThF 10:30 – 11:30 AM
Tu 9:30 – 11:30 AM
or by appointment

All office hours will be held on Canvas via Collaborate Ultra sessions.

Class Meetings: MWF 9:10 AM – 10:10 AM

All class meetings will be held on Canvas via Collaborate Ultra sessions.

Prerequisites: A grade of C or better in CS 271

Class Web Page: UWO Canvas

You are expected to check the CS 331 Canvas course web site daily since it will be constantly updated with materials for this course, including daily slides, daily Collaborate Ultra lecture session links, daily reading assignments, and programming assignment handouts. **You are also expected to check your email daily** for course announcements.

References:

A draft/in-progress interactive online book I am currently working on with Dr. Naps hosted at *canvas.instructure.com*. Note that this is a ***different Canvas server than the one UWO uses for the class web page*** listed above. To access this book for the first time, use the following link to the ***PL Book 2021***: **https://canvas.instructure.com/enroll/J6K8LJ** and **make sure to use your *uwosh.edu* email address** as your Login ID when setting up your account for this book so that I can give you appropriate credit for doing the interactive, practice problems that are interspersed throughout the book.

Tests: Exam #1: Week of March 8 (± one week) with 10-day prior notice
Exam #2: Week of April 12 (± one week) with 10-day prior notice
Exam #3: Week of May 10

In this synchronous course, lectures will take place live during the regular class time on Collaborate Ultra. **Make sure to be available during EACH AND EVERY class session.** This is also when all exams will be administered on Canvas. Lectures will be recorded for the benefit of students who would like to listen to parts of them again while studying. Office hours will also take place on Collaborate Ultra. I will always be available for questions during the times listed above. You are also encouraged to set up an appointment by email if these times do not work for you.

Accommodations: The University of Wisconsin Oshkosh supports the right of all enrolled students to a full and equal educational opportunity. It is the University's policy to provide reasonable accommodations to students who have documented disabilities that may affect their ability to participate in course activities or to meet course requirements.
Students are expected to inform instructors of the need for accommodations as soon as possible by presenting an Accommodation Plan from either the Accessibility Center, Project Success, or both. Reasonable accommodations for students with disabilities is a shared instructor and student responsibility.

The Accessibility Center is part of the Dean of Students Office and is located in 125 Dempsey Hall. For more information, email accessibilitycenter@uwosh.edu, call 920-424-3100, or visit the Accessibility Center Website.

Disclosure: Students are advised to see the following URL for disclosures about essential consumer protection items required by the Students Right to Know Act of 1990:

https://uwosh.edu/financialaid/resources/consumer-information/

Learning Outcomes:

- Given an English description of a formal language, the student will be able to construct a context-free grammar that generates this language.
- Given a context-free grammar and the source code for a program, the student will be able to parse the program according to the grammar, and to produce a parse tree of the program or identify syntactic errors in the program.
- Given a context-free grammar in Backus-Naur Form (BNF), the student will be able to convert it to an equivalent, more compact grammar in Extended BNF.
- Given a context-free grammar, the student will be able to determine whether the grammar is ambiguous or not.
- Given a program and a scoping mechanism (static or dynamic), the student will be able to trace the execution and infer the output of the program.
- Given a formal description of an operation, the student will be able to implement it in the functional paradigm using either recursion or a computational pattern such as filtering, mapping, or folding, or a combination thereof.
- Given an imperative program and a set of eager/lazy parameter-passing mechanisms, the student will be able to simulate, for each mechanism, the sequence of updates that take place in memory as the program executes.
- Given the description of an operation applicable to an infinite data structure, the student will be able to program this operation in a functional language using lazy evaluation.
- Given a functional language with higher-order functions, the student will be able to simulate recursion using the Y combinator.
- Given a working interpreter for a programming language, the student will be able to adapt the interpreter to a similar language with a different concrete syntax.
- Given a working interpreter for an imperative programming language, the student will be able to implement an interpreter for an enhanced language with additional features (such as a new data type or a new language construct), or different semantics (such as a different parameter-passing mechanism).

- Given a problem involving different variants of a data type (e.g., different types of expressions) and different operations on those data (e.g., evaluation, pretty-printing, type-checking, etc.), the student will be able to compare and contrast the procedural/functional approach and the object-oriented approach and to discuss the strengths and weaknesses of each approach. Given a desirable property of a program or a software development process (e.g., programming convenience, ease of prototyping, support for code reuse and code evolution, high runtime performance, etc.), the student will be able to discuss the pros and cons of static checking and dynamic checking with respect to this desirable property.
- Given a programming language and its type system, the student will be able to define the properties of soundness (or safety) and completeness of this type system, and to compare and contrast weak typing and strong typing.

Topic Coverage: We will cover the following topics:

- Grammars and formal syntax
- The functional programming paradigm
- Recursion in programming
- Scope and lexical structure of programs
- The lambda calculus as a formal model of functional languages
- Writing interpreters for small languages
- Evaluation order and parameter-passing
- Type systems

Note that the catalog course description shown below is out of date:

> *A study of programming languages. Topics covered include: formal syntactic description, methods of implementation, and language features such as recursion, block structure, string processing, and list processing. Specific high level programming languages are studied to demonstrate the use of these language features.*

Course Grading Policy

Your final grade for this course will be based on three components, namely exams, assignments, and class preparation/participation. Your overall numerical grade for the course will be computed as the weighted sum of the component grades using the weights in the following table:

Component	Weight
Exam 1	20%
Exam 2	20%
Exam 3	20%
Assignments	30%
Class preparation/participation (daily)	10%

Each assignment will be worth between 20 and 100 points. The corresponding 30% of your overall grade will be obtained by adding up all of your assignment scores and dividing the resulting total by the sum total of all assignments' worth. The grading for class preparation/participation is explained below.

Finally, your letter grade for the course will be computed as follows:

Numerical Score	Grade	Numerical Score	Grade
≥ 92	A	≥ 72	C
≥ 90	A-	≥ 70	C-
≥ 88	B+	≥ 68	D+
≥ 82	B	≥ 62	D
≥ 80	B-	≥ 60	D-
≥ 78	C+	< 60	F

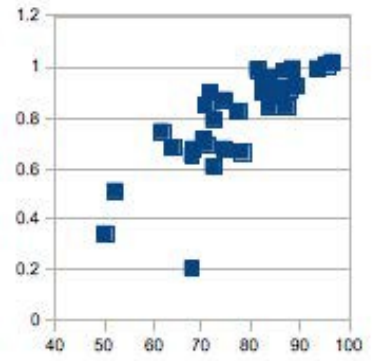
While this overall grading scheme is fixed, I will be happy to discuss any issue you may have with individual grades. If you notice a mistake or have a question regarding a specific grade, please come and talk to me *as soon as possible*. Do not wait until the end of the semester to bring up grading issues. Also, I will *not* be available to discuss grades after the end of the final week.

Attendance and Participation

You are expected to not only attend **every** class meeting but also to come **prepared** for and **participate** actively in it. Necessary preparation requires you to have studied and assimilated the material covered in previous sessions, to have completed the reading assignment for the day, to have contacted me outside of class to discuss any questions you may have, and to have completed the assignments on time. One additional and crucial component of class preparation/participation are the daily practice problems. At the end of most of our class periods, I will make available to you a set of practice problems covering what we discussed in class that day. Research on effective studying skills and college success shows that the time to work on these practice problems is immediately after the material is covered in class. You are also encouraged to discuss practice problems with your classmates in a spirit of mutual help toward better understanding of how to solve them. We will discuss the practice problems at the beginning of the class following their distribution. Your solutions to the practice problems are due no later than 8:30AM on the Monday, Wednesday, or Friday following the day of their distribution. These solutions must be submitted within the PL book web site, that is, by clicking the answer button (typically called "Check Answer") associated with each practice problem.

Each problem (i.e., practice problem or proficiency exercise) will be worth one point. The component of your overall course grade labeled "Class preparation/ participation" and weighted 10% will be obtained as the ratio of the sum of points earned over all practice problems to the total number of practice problems. If you have participated in class the day the practice problem was distributed, have made a good faith effort to work on the practice problem, and are stuck on it, I will be more than happy to help you with it if you contact me within THREE days of the distribution of the practice problem. After those three days (not counting weekends), because you have made the choice *not* to learn effectively, I will not be able to help you grapple with this particular practice problem. Do ***not*** wait until before an exam to ask questions about the daily practice problems. Master them right after they are assigned.

Although the practice problems only count for 10% of your grade, the following correlation from a previous course between the total score on practice problems (on a 0 to 1.0 vertical scale) and the final course grade (on a horizontal scale of 0 to 100) is indicative of their true importance:



It is hard to imagine how a student could do well in this course while skipping (or not working conscientiously on) the practice problems, missing classes, or attending them unprepared (e.g., by not completing the daily reading assignments BEFORE class). On the positive side, I have high expectations for my students and will always support and encourage you. I **strongly encourage you to ask any question** or raise any issue you have with the course either during or at the end of class, or during office hours. I will also gladly help you by appointment (just send me an email with a list of time slots when you are available). While I will help you as soon as my schedule permits, do not expect me to be widely available just before an assignment is due or an exam is scheduled. Hint: Start early and plan ahead!

Late Submissions

I will describe the submission procedure for your assignments when the time comes. However, let me point out right away that each assignment will come with a deadline (day and time, typically 8:30AM) after which any submission will be considered late. The late-submission policy works as follows:

Turned in	Penalty
On the due date but after the deadline	30%
The day after the due date	60%
More than one day after the due date	100%

Note that assignments that are two or more days late receive no points. **Weekend days and holidays count as "regular days" when computing late penalties**. The late day starts precisely at midnight. So, each one of the following timestamps: 12:00:00 AM, 12:00:01 AM, etc., is considered to be “the next day.” Extensions on assignments may be granted at my discretion if you provide a valid justification (in the form of a written excuse from a medical doctor or the Dean of Students Office) **before** the due date. Late submissions can easily be avoided by starting to work on the assignment right away and asking for help early if you get stuck.

NO late submissions will be accepted for daily practice problems. They *cannot* be made-up.

If you miss a scheduled exam, you **may** be able to take a make-up exam provided you give me a valid justification (see above), ahead of time if possible. Only one make-up exam will be given. It will be a comprehensive exam scheduled at the end of the semester.

Collaborating versus Cheating

You are encouraged to work with others when working on the practice problems, as long as everyone comes out of the collaborative work understanding and being able to apply to similar problems the knowledge or skills that the practice problem was targeting.

For assignments, you will have the choice to work with one or two partners. You may not share or even discuss your work with anybody but your partner(s) unless you can live with a zero and the other potential academic sanctions of cheating (see the UWO Student Discipline Code, Chapter UWS 14).

You are of course encouraged to ask me for help if you get stuck after making a good faith effort at solving a problem. That is why I have daily office hours!

In conclusion, remember that computer science classes require a lot of work in addition to active participation in class. It takes considerable practice to develop the technical and analytical skills targeted by this course. You will need to spend **at least (and typically more than) three hours of effort outside of class for each in-class hour**. Having said this, I expect every hardworking student to do well in this course.

Have fun this semester and good luck!