

# CS 558: Software Foundations

## Fall 2023

Matthew R. Lakin

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### 1 Course information

#### 1.1 Lectures

Lecture day/time: Tuesdays and Thursdays 12:30–1:45pm

Lecture location: Centennial Engineering Center room 1028

#### 1.2 Instructor

Matthew Lakin

Email: [mlakin@cs.unm.edu](mailto:mlakin@cs.unm.edu)

Office hours: Tuesdays 3-5pm

Office hours location: Farris Engineering Center room 3240

#### 1.3 Course topics and format

This course studies the theory used to describe and define programming languages and to guide their implementation. Our approach is type-based, in the spirit of our textbook, Pierce's Types and Programming Languages (TAPL). As a prelude, the course offers a brief overview of functional programming techniques and of programming language features found in the purely functional programming language Haskell.

The course is intended for first-year graduate students, but advanced undergraduates are welcome as well. No specific courses are prerequisites, but programming experience and mathematical maturity are necessary. Experience with functional programming (at the level of UNM CS357) and discrete mathematics is strongly recommended.

The course will provide students with the background they need for CS550.

The course consists of lectures, homework assignments (primarily programming based), quizzes, two mid-term examinations, and a final examination.

## 1.4 Assignments

There will be two midterm exams, and a final exam covering the entire course. These may be administered on paper or via UNM Learn.

Programming-based homework assignments may be given: in the early part of the course these tasks will be drawn from the general domains of mathematics, science, and engineering, to practice programming skills; in the later part of the course the tasks will correspond to implementation of programming language theory. Short written homework assignments may be given to consolidate lecture material; they may take the form of short algebraic proofs of program fragment equivalence, or consideration of small language extensions. Homework assignments will be submitted via UNM Learn.

There will also be regular quizzes administered online via UNM Learn.

## 1.5 Textbook (optional)

- Benjamin C. Pierce, Types and Programming Languages, MIT Press, 2002, ISBN-10: 0262162091.

## 1.6 Grading

You are expected to attend class regularly, read any assigned reading before class, and participate in class discussion. The grade will be determined as follows:

- Homeworks: 40% total
- Exams: 50% (15% for each midterm, 20% for the final)
- Quizzes: 10%

Note that no requests for grade changes or grade mode changes will be considered after the final class. There will also be no extra credit assignments or “do-overs” for homeworks, exams, or quizzes.

## 1.7 Communication

The Loboweb email list functionality will be used for administrative announcements. Lecture notes and homework assignments will be uploaded to the UNM Learn page for the class.

# 2 Topics

The topics covered in class will be a subset of the following:

- Topics in functional programming
  - functional programming and Haskell
  - prelude types and classes

- functions and list comprehensions; unit testing; literate programming; interactive programs
- recursive and higher-order functions
- declaring types and classes
- lists in depth: map, filter, and their algebraic laws
- lists in depth: foldr, scanr, and their algebraic laws
- trees with folds, binary heap trees, rose trees
- efficiency: accumulating parameters, tupling, fusion, and deforestation
- modules and abstract data types
- lazy evaluation and infinite data structures; approximation ordering; cyclic structures; streams
- monads
- metaprogramming in a functional programming language
- Topics in programming language semantics
  - syntax
  - operational semantics
  - simple imperative languages
  - lambda calculus syntax and reduction
  - programming in the lambda calculus
  - combinators and combinator reduction
  - types
  - simply typed lambda calculus
  - simple extensions (ascription; let-bindings; records; variants; recursion)
  - references
  - exceptions
  - subtyping
  - recursive types
  - type reconstruction
  - unification
  - universal polymorphism
  - program transformations

### 3 Credit-hour statement

This is a three credit-hour course. Class meets for two 75-minute sessions of direct instruction for fifteen weeks during the Fall 2023 semester. Students are expected to complete a minimum of six hours of out-of-class work (or homework, study, assignment completion, and class preparation) each week.

## 4 Academic integrity statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in course work may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

**All students will be required to sign and submit a warning regarding issues of academic integrity and possible sanctions prior to any submissions being graded.**

## 5 Accommodation statement

UNM is committed to providing equitable access to learning opportunities for students with documented disabilities. As your instructor, it is my objective to facilitate an inclusive classroom setting, in which students have full access and opportunity to participate. To engage in a confidential conversation about the process for requesting reasonable accommodations for this class and/or program, please contact Accessibility Resource Center at [arcsrvs@unm.edu](mailto:arcsrvs@unm.edu) or by phone at 505-277-3506.

## 6 Title IX statement

To meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered “responsible employees”. This designation requires that any report of gender discrimination, which includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA, must be reported to the Title IX Coordinator at the [Office of Compliance, Ethics, and Equal Opportunity](#). For more information on the campus policy regarding sexual misconduct, see: <https://policy.unm.edu/university-policies/2000/2740.html>