CORE EXAMINATION
Department of Computer Science
New York University
May 12, 2000

This is the common examination for the M.S. program in CS. It covers core computer science topics: Programming Languages and Compilers, Operating Systems, and Algorithms. The exam has two parts. The first part lasts three hours and covers the first two topics. The second part, given this afternoon, lasts one and one-half hours, and covers algorithms.

Attempt all of the questions.

Use the proper booklet for each question. Each booklet is marked with the Area and Question number, in the form PL&C1, PL&C2, PLC&C3, OS1, OS2, ALGS1, ALGS2, ALGS3. Use the appropriate booklet for each question. DO NOT put your name on the exam booklet. Instead, your exam number must be on every booklet.

You will be graded according to your exam number, shown on the envelope containing the booklets. Remember your exam number: when grades are given out, they will be published according to this number, not by name.

Make sure to put your name and student ID number are on the envelope. This is the only place where your name appears. Please include all the booklets inside the envelope. You can keep the exam.

Good luck!

use the booklet labelled PLC1

a) Give a grammar for expressions that has left-recursion.

b) What type of parser cannot handle left-recursion? Explain.

c) explain how to remove left-recursion from a grammar (an informal algorithm is sufficient). Apply your procedure to the grammar of part a).

d) Does the new grammar of part a) recognize the same language as that of part c)? Justify your answer by drawing the parse trees for some simple expression, using each grammar. (Hint: look at associativity).

use the booklet labelled PLC2

a) In C++ or Ada, define a parametrized unit (template or generic package) to manipulate doubly-linked lists, all of whose elements have the same type. No need to write the implementation of list primitives. Use this to declare a list of integers, and a list of complex numbers, defined as pairs of real numbers.

b) We want to create a similar facility in Java, namely we want to write ONCE the primitives for a doubly-linked list, and use this definition to create HOMOGENEOUS lists with a specific element type. Explain how to do this, and compare your Java solution with the one for part a) in terms of ease of use, type safety, and efficiency.

use the booklet labelled PLC3

The Map function, in LISP and its descendants, takes a list L and a function F, and build a new list by apply F to each of the elements of F.

a) In your favorite functional language, write the definition and body of Map.

b) In your favorite imperative language, write a similar definition and body. Explain precisely how the function parameter F is handled.

For both questions, use the proper syntax and semantics of the languages you choose.

use the booklet labelled OS1

Consider two solutions to the dining philosphers problem. In Solution 1, each philosopher attempts to acquire teh left and right chopsticks in the same order (say the "even" order: the left one followed by the right one). In Solution 2, the even-numbered and odd-numbered philosophers acquire the left and right chopsticks in opposite order.

(a) Construct a **resource allocation** graph (also called a reusable resource graph) showing a deadlock situation for Solution 1. Assume that there are five (5) philosophers.

(b) Explain why Solution 2 avoids deadlock by discussing how the resource allocation graphs that can result from the execution of the algorithm differ from the graph in part (a).

use the booklet labelled OS2

In a system that supports virtual memory, consider an applcation process that does no application-level I/O but is observed to generate a constant rate of **180 faults** for **4 KB** pages per second. Servicing a page fault consumes bf 50/*micro***s** of CPU overhead and **5 ms** of disck access time. Answer the following questions:

(a) What is the user CPU utilization for this process?

(b) Assuming that the process requires 60 seconds to complete execution with the above settings, how long would it take if the CPU speed were doubled? What is the new paging rate?