

CSci 4651 Fall 2003
Review questions for the midterm exam

The exam covers lecture material up to (including) Friday, October 3rd, all the assigned reading including Chapter 5 and the handouts, and the material of the first 3 problem sets. You may use any printed materials on the exam and any handwritten notes **written by you**. Computers may not be used on the exam.

The purpose of the review questions is to help you understand the material better, to get an idea of the format of exam questions, and to identify areas that you need to focus on preparing for the exam. However, there is no guarantee that the exam questions will be very similar to the review questions or that they will cover exactly the same topics. You are responsible for all the material covered in class, regardless of whether it appears in review questions or not.

Problem 1. Suppose you are given a function $Halt_2(P, x, y)$ that can determine whether a program P that takes two string inputs x and y halts on these two inputs. Is it possible to solve the halting problem, i.e. to construct a function $Halt(P, n)$ which takes a one-input program P and its input n and determines whether P halts on n ? Please explain your answer in detail.

Problem 2. Consider the following Java function

```
private int f (int x, int y) {  
    return x * (x + x * x);  
}
```

Is it possible to replace this function by the function given below (and change all the function calls to `f` in the program accordingly) without changing the behavior of the program?

```
private int f (int x) {  
    return x * (x + x * x);  
}
```

Problem 3. What will be the result of each of the following sequences of Scheme code?

1. `((lambda (x) (x 5)) (lambda (y) (lambda (z) y)))`

2.

```
(define mystery (lambda (x) (  
    cond ((lambda (x) (x x)) (lambda (x) (x x))) 1)  
    ( true 2))))  
  
(mystery 3)
```

3.

```
(define a (cons 5 3))  
(define b (cons a a ))  
(set-car! a 4)  
b
```

Problem 4. What is the purpose of intermediate code generator in a compiler? Why is the source code converted into intermediate code first, instead of being

converted directly to the target (machine-specific) code?

Problem 5. Given the grammar

$$S \rightarrow \epsilon \mid (S) \mid SS,$$

draw all possible parse trees for $()()()$. Now consider this grammar:

$$S \rightarrow \epsilon \mid (S) \mid (S)S$$

Draw all possible parse trees for the same string.

Do the two grammars describe the same set of strings? Is the first grammar ambiguous? Is the second one? Please explain your answers.

Problem 6. Suppose a language designer wants to make sure that programs in the language go into infinite loops as little as possible. Would you recommend the call-by-value or the call-by-name evaluation strategy? Why?

Problem 7. Some of the following ML expressions are correct, and some are not. For the incorrect ones, please explain what the error is. For the correct ones, please show the result (including the type). Assume that x and y are some integer variables and r is an integer reference cell.

```
if (x<y) then 5 else false;
(fn x => x + 1) 3;
fun f(x, 0) = 2 * x
  | f(0, y) = 2 * y
  | f(x, y) = 3.5 * (x + y);
fun g(x, y) = x < 2 * y;
fun foo(x, y) = if x then y + 4 else y * 2;
!r := !r + 1;
fun what(x, nil) = true
  | what(nil, y) = false
  | what (x::xs | y::ys) = what(xs, ys);
```

Given the definition of $what(x,y)$ above, are the following correct?

```
what([1,4,5], []);
what([true,false], ['apples', 'bananas', 'oranges']);
```

What is the purpose of the function $what(x, y)$?