

Name \_\_\_\_\_

# CS471, Programming Language Structure I

## Spring, 2001

### Final Examination

This is a take-home exam. You may work with others in the class on all or part of the exam., but you *must* indicate your helper(s) on your answers. If you do not, and there is evidence of copying of answers, or of soliciting answers uninvited, you may receive zero for the whole exam. The total points for each question or part of a question follows it in parentheses, thus: *(12 points)*

***Due date: May 10<sup>th</sup> before 5pm.***

### 1

Below is a standard BNF rule. Which of the strings following it can be generated by the rule, and which cannot? *(4 each)* Show the parse tree, partial or complete, in each case.

$\langle S \rangle ::= rL \mid r\langle S \rangle L \mid \langle S \rangle \langle S \rangle$

- (a) rrLLrL
- (b) rLrrLrLL
- (c) rrLrLrLLrLrrL

**2**

In the program below what values are printed by the print statement for

- a) static scoping and call-by value (6)?
- b) dynamic scoping and call-by-reference? (6) and
- c) call-by name? (6)

```
PROGRAM what!;  
index:integer; A:array[1..3] of integer;  
  
procedure P(x:integer);  
begin  
    index:=2;  
    A[index]:=4;  
    x:=x+2;  
    index:=3;  
    A[index]:=9;  
    x:=x+3  
end;  
  
begin  
    index:=4;  
    A[1]:=3; A[2]:=2; A[3]:=3;  
  
    begin  
        index:integer;  
  
        index:=2;  
        P(A[index])  
    end;  
  
    PRINT(A[1],A[2],A[3])  
end.
```

**3**

Consider the three Java class definitions below.

- a. Which statement in RCell2 will not compile and why? (6)
- b. If this line is removed the class RCell2 will compile but causes a run-time error. Which statement causes the error and why? (6)
- c. What does the program print when both offending statements are removed? Explain your answer. (8)

*Note it is not sufficient just to report the compiler and run-time system messages. You must explain what is happening and why in terms of the features of object-oriented languages of which Java is just one example.*

```
public class Cell {
    public void print() {
        System.out.println("Cell");
    }
}

public class RCell extends Cell {
    public void print() {
        System.out.println("RCell");
    }
}

public class RCell2 {
    public static void main(String args[]) {
        RCell r1 = new RCell();
        Cell c1 = new Cell();
        r1.print();
        c1.print();
        c1 = r1;
        c1.print();
        RCell r2 = new RCell();
        Cell c2 = new Cell();
        r2 = c2;
        r2 = (RCell)c2;
        r2 = (RCell)c1;
        r2.print();
    }
}
```

**4**

In one sentence, what does the following Scheme function do? (10)

```
(define (mystery l)
  (cond ((null? list) '())
        ((symbol? l) (list l))
        (else (append (mystery (car l)) (mystery (cdr l))))))
```

Show the workings of the function as a sequence of equivalent expressions starting from the following expression. (14)

```
(mystery '(a (b) ((c))))
```

**5**

The following Prolog program finds all descendants of `jim` with the query `ancestor(jim,X)`, and resatisfaction, but then fails to return.

- a. Show the goal tree of the execution in sufficient detail to explain why this occurs. (18)
- b. How might the program be altered to prevent the failure to return an answer? Explain your answer. (8)

```
parent(jim,mary).  
parent(jim,annie).  
parent(annie,charles).
```

```
ancestor(A,B) :- parent(A,B).  
ancestor(A,B) :- ancestor(A,C),parent(C,B).
```