COP4020 Fall 2003 – Midterm Exam

Name: _____ (Please print)

Put the answers on these sheets. Use additional sheets when necessary. You can collect 100 points in total for this exam.

1. Which language is considered the *first high-level programming language*? (mark **one**, 4 points)

   (a) Pascal

   (b) C++

   (c) Fortran

   (d) Lisp

2. Which phases are part of the *front-end* of a compiler? (mark **one or more**, 4 points)

   (a) Code improvement

   (b) Semantic analysis

   (c) Syntax analysis

   (d) Target code generation

3. What is the value of the Scheme expression (`cons 0 (member 3 '(1 2 3))`)? (mark **one**, 4 points)

   (a) `(0 1 2 3)`

   (b) `(0)`

   (c) `3`

   (d) `(0 3)`

4. What is a *special form* in Scheme? (mark **one**, 4 points)

   (a) A function with a special name

   (b) A function with special evaluation rules for arguments

   (c) A list

   (d) None of the above

5. A *recursive descent parser* is... (mark **one or more**, 4 points)

   (a) A top-down parser

   (b) A bottom-up parser

   (c) A parser for LR grammars

   (d) A predictive parser for LL grammars

6. The `gdb` tool is a... (mark **one**, 4 points)

   (a) A compiler

   (b) An interpreter

   (c) A debugger

   (d) A linker

7. What is a *fixed format* language? (mark **one**, 4 points)

   (a) A language with a fixed number of keywords

   (b) A language in which the relative positions of tokens with respect to eachother is important rather than the position of the tokens on the page

   (c) A language in which indentation is significant, hence the amount of spacing is meaningfull and influences the execution of a program

   (d) A language with formatted read and write constructs

8. Consider the program below:

```
procedure P(A:real)
   var X:real;
   procedure Q(B:real)
      var Y:real;
   begin (* body of Q *)
      ...
   end (* body of Q *)
   procedure R(C:real)
      var Z:real;
   begin (* body of R *)
      ... <== (*)
   end (* body of R *)
begin (* body of P *)
   ...
end (* body of P *)
```

   What is the complete reference environment at the (*) location in this program? (mark **one**, 4 points)

   (a) A, C, P, Q, R, X, Z

   (b) A, C, P, R, Z

   (c) A, B, C, P, Q, R, X, Y, Z

   (d) C, R, Z

9. Fill in the blanks. Choose from: *language design, language implementation, programing writing, compile, link. load*, and *run.* (8 points)

   (a) Dynamic semantic errors are detected at _____ time.

   (b) Static semantic errors are detected at _____ time.

   (c) The syntax of a new programming language is determined at _____ time.

   (d) Multiple object codes are merged into one executable at _____ time.

10. What is a *first-class object* in a programming language? (7 points)

11. Draw the typical *subroutine frame* layout and explain the functionality of the frame slots. (10 points)

12. Explain *heap allocation*. Describe two common block allocation selection algorithms, two algorithms that maintain pools of free blocks, and two fragmentation problems. (12 points)

13. Credit card numbers are validated using the LUHN formula. The formula combines the digits of a credit card number in a specific way to compute a total sum of which the mod 10 value must be zero for valid card numbers. Consider the following (incomplete) augmented grammar to verify credit card numbers with a simplified LUHN algorithm:

$$\langle cardno \rangle \quad \rightarrow \quad \langle digits \rangle \qquad\qquad cardno.\text{ok} := (digits.\text{len} == 16\ \&\&\ digits.\text{sum mod } 10 == 0)$$

$$\langle digits_1 \rangle \quad \rightarrow \quad \langle digit \rangle\ \langle digits_2 \rangle \quad \ldots$$

$$\langle digits \rangle \quad \rightarrow \quad \langle digit \rangle \qquad\qquad \ldots$$

$\langle digit \rangle$	$\rightarrow$	0	$digit.\text{val} := 0$
$\langle digit \rangle$	$\rightarrow$	1	$digit.\text{val} := 1$
$\langle digit \rangle$	$\rightarrow$	2	$digit.\text{val} := 2$
$\langle digit \rangle$	$\rightarrow$	3	$digit.\text{val} := 3$
$\langle digit \rangle$	$\rightarrow$	4	$digit.\text{val} := 4$
$\langle digit \rangle$	$\rightarrow$	5	$digit.\text{val} := 5$
$\langle digit \rangle$	$\rightarrow$	6	$digit.\text{val} := 6$
$\langle digit \rangle$	$\rightarrow$	7	$digit.\text{val} := 7$
$\langle digit \rangle$	$\rightarrow$	8	$digit.\text{val} := 8$
$\langle digit \rangle$	$\rightarrow$	9	$digit.\text{val} := 9$

(a) The number of digits must be 16 and the sum of the digits mod 10 must be zero. Complete the semantic rules above to compute the *digits*.len and *digits*.sum values for validation. (8 points)

(b) Which attributes are synthesized or inherited? Note: *cardno*.ok is synthesized. (3 points)

	synthesized	inherited
cardno.ok	×	
digits.len		
digits.sum		
digit.val		

14. Consider the following program:

```
x : integer /* global */
procedure one
   x := 1
procedure two
   x : integer
   x := 2
   one()
   write_integer(x)
begin /* main program */
   two()
end /* main program */
```

(a) Assuming that the programming language uses static scoping, what value does this program print? (5 points)

(b) Assuming that the programming language uses dynamic scoping, what value does this program print? (5 points)

15. Consider the following Scheme function:

```
(define f
  (lambda (lst)
    (cond
      ((null? lst))          0)
      ((number? (car lst)) (+ 1 (f (cdr lst))))
      (else                  (f (cdr lst))
    )
  )
)
```

Explain what the function f computes for lists. Note: consider (f '(1 a b 2)) for example. (10 points)