COP4020 Fall 2004 – 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. What was the *first* functional language? (mark **one**, 4 points)

    (a) Algol 60

    (b) Haskell

    (c) Lisp

    (d) APL

2. Which semantic check listed below and adopted in a compiled language like Java is considered a *dynamic semantic check*? (mark **one**, 4 points)

    (a) Subroutine calls provide the correct number and types of arguments

    (b) Array subscript expressions lie within the bounds of the array

    (c) Every identifier is declared before it is used

    (d) Every function contains at least one statement that specifies a return value

3. What is the form in which a program is passed from the scanner to the parser? (mark **one**, 4 points)

    (a) Source code

    (b) Abstract syntax tree

    (c) Parse tree

    (d) Tokens

4. Given the regular expression below, which strings are valid? (mark **one or more**, 4 points)

$$R \rightarrow (\texttt{a} \mid \texttt{b} \mid \texttt{c} \mid \texttt{\$}) \; (\texttt{0} \mid \texttt{1} \mid \texttt{\_})^\star \; (\texttt{.} \; (\texttt{0} \mid \texttt{1} \mid \texttt{\_})^\star \mid \varepsilon)$$

    (a) `a`

    (b) `$1.00`

    (c) `.00`

    (d) `$_._`

5. What kind of parsing technique(s) can be used to implement a parser for an LL(1) grammar? (mark **one or more**, 4 points)

    (a) Top down parsers

    (b) Recursive descent parsers

    (c) Bottom up parsers

    (d) None of the above

6. One of the languages listed below is a *fixed format language*, i.e. indentation and spacing affect program syntax and compilation. Which one? (mark **one**, 4 points)

    (a) Fortran 77

    (b) Java

    (c) C++

    (d) Pascal

7. When does a *dangling reference* to an object occur? (mark **one**, 4 points)

    (a) When the object lifetime exceeds the binding time

    (b) When the binding time exceeds the object lifetime

    (c) When the object is not in scope

    (d) None of the above

8. Consider the Scheme function:

```
(define fun
  (lambda (arg)
    (cond
      ((null? arg)         '())
      ((number? (car arg)) arg)
      (else                (fun (cdr arg)))
    )
  )
)
```

   Which of the following function evaluations are correct? (mark **zero or more**, 4 points)

    (a) `(fun '(a b))` evaluates to `0`

    (b) `(fun '(2 1))` evaluates to `2`

    (c) `(fun '(a 1 b))` evaluates to `1`

    (d) `(fun '(1 2 3))` evaluates to `3`

9. Fill in the blanks. Select from: *static, stack, heap, buddy system, fibonacci heap, best-fit, first-fit, internal, external.* (4 points)

    (a) _____ objects are allocated in a last-in, first-out order, usually in conjunction with subroutine calls and returns

    (b) When a heap-allocated object is smaller than the selected free block and the remaining free space is unused this causes _____ fragmentation

    (c) The _____ maintains a pool of lists of free blocks of size 2^k

    (d) The _____ heap allocation algorithm searches the entire free list for the smallest block that can hold the object

10. What makes a programming language successful? List at least four of the five reasons given in the textbook. (8 points)

11. Describe the "dangling else problem". That is, describe why the code fragment below can have different meanings and why this problem is caused by the grammar. (8 points)

```
if C1 then if C2 then S1 else S2
```

12. Consider the program:

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

What is the reference environment at the location marked (*) in this program? (10 points)

13. What are the phases of a compiler? List at least four of these phases. (8 points)

14. Consider the following program:

```
x : integer /* global */
procedure one
   x := 1
procedure two
   x : integer
   x := 2
   one()
begin /* main program */
   x := 0
   two()
   write_integer(x)
end /* main program */
```

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

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

15. Consider the following S-attributed LL(1) grammar:

$$
\begin{array}{rcl}
\langle decls \rangle & \rightarrow & \langle decl \rangle \; \langle more\_decls \rangle \qquad decls.\text{set} := \{\, \langle decl.\text{id}, \; decl.\text{type}\rangle \,\} \cup more\_decls.\text{set} \\
\langle more\_decls_1 \rangle & \rightarrow & ; \; \langle decl \rangle \; \langle more\_decls_2 \rangle \quad more\_decls_1.\text{set} := \{\, \langle decl.\text{id}, \; decl.\text{type}\rangle \,\} \cup more\_decls_2.\text{set} \\
\langle more\_decls \rangle & \rightarrow & \texttt{\$\$} \qquad more\_decls.\text{set} := \emptyset \\
\langle decl \rangle & \rightarrow & \langle id \rangle : \langle type \rangle \qquad decl.\text{id} := id.\text{val}; \; decl.\text{type} := type.\text{val} \\
\langle type \rangle & \rightarrow & \texttt{int} \qquad type.\text{val} := \texttt{int} \\
\langle type \rangle & \rightarrow & \texttt{real} \qquad type.\text{val} := \texttt{real}
\end{array}
$$

(a) Is the sentence
   `int x; int y; $$`
   syntactically correct (**yes** or **no**)? (note: `$$` denotes end of line) (4 points)

(b) (8 points) Draw the parse tree of
   `a:int; b:real $$`

(c) Annotate the parse tree with the attribute values. (8 points)