

## COP4020 Fall 2001 – Midterm Exam

Name: \_\_\_\_\_ (Please print)

*Put the answers on these sheets. Use additional sheets when necessary. Show how you derived your answer for open questions (this is required for full credit and helpful for partial credit). You can collect 100 points in total for this exam.*

1. What language is mainly intended for *business programming*? (mark **one**) (4 points)
  - (a) Cobol
  - (b) Basic
  - (c) C++
  - (d) Fortran 77
2. What language is mainly intended for *numerical programming*? (mark **one**) (4 points)
  - (a) Basic
  - (b) Fortran 77
  - (c) Ada
  - (d) Pascal
3. What language was the first *block structured* language? (mark **one**) (4 points)
  - (a) C++
  - (b) Fortran 77
  - (c) Cobol
  - (d) Algol 60
4. What language was the first to have the concept of a *class* for data abstraction? (mark **one**) (4 points)
  - (a) C++
  - (b) Algol 60
  - (c) Simula 67
  - (d) Smalltalk-80
5. Which language(s) is/are *object oriented* or hybrids with object oriented features? (mark **one or more**) (4 points)
  - (a) Fortran 77
  - (b) Ada 95
  - (c) Smalltalk-80
  - (d) Cobol
6. Which of the following language(s) is/are *functional languages*? (mark **one or more**) (4 points)
  - (a) PL/I
  - (b) Lisp
  - (c) Haskell
  - (d) Cobol

7. Which of the programming tools below is also called a *virtual machine*? (mark **one**) (4 points)
- (a) Preprocessor
  - (b) Compiler
  - (c) Interpreter
  - (d) Linker
8. In a *strongly typed* language ... (mark **one**) (4 points)
- (a) ... all objects are polymorphic
  - (b) ... type errors are always detected
  - (c) ... recursion is not supported
  - (d) ... all variables are statically allocated
9. Some languages perform array bounds checking, which means that array subscript values (indices) must stay within the specified array bounds. The checks cannot always be performed at compile time, because array subscript values often depend on program input data. What kind of error occurs when an array subscript value is out of bounds at run time? (mark **one**) (4 points)
- (a) Lexical error
  - (b) Syntax error
  - (c) Static semantic error
  - (d) Dynamic semantic error
10. What is the value of the Scheme expression `(car (cdr (cdr '(1 2 3 4 5))))`? (mark **one**) (4 points)
- (a) `(2 3 4 5)`
  - (b) `(1 2 3)`
  - (c) `3`
  - (d) `()`
11. Consider the Scheme function `f` defined below:

```
(define f
  (lambda (n k)
    (cond
      ((= n k) 0)
      (> n k) n
      (else k)
    )
  )
)
```

What is the resulting value of `(f 5 1)` in Scheme? (4 points)

- (a) 0
  - (b) 1
  - (c) 5
  - (d) `#f`
12. Fill in the blank (choose from: front-end, back-end, top-down, bottom-up, synthesized, inherited, LL, LR, S-attributed, L-attributed) (10 points)
- (a) Recursive descent is a \_\_\_\_\_ parser for a \_\_\_\_\_ grammar.
  - (b) The values of \_\_\_\_\_ attributes flow upward in a parse tree.
  - (c) Syntax checking is performed in the \_\_\_\_\_ part of a compiler.
  - (d) When all attributes are synthesized, the attribute grammar is called \_\_\_\_\_.

13. What is a scanner and what is it used for? (explain) (7 points)

14. Consider the LL(1) grammar

```
⟨robot⟩ → walk ⟨dir⟩ ⟨robot⟩
⟨robot⟩ → pick ⟨obj⟩ ⟨robot⟩
⟨robot⟩ → drop ⟨obj⟩ ⟨robot⟩
⟨robot⟩ → stop
⟨dir⟩ → north
⟨dir⟩ → east
⟨dir⟩ → south
⟨dir⟩ → west
⟨obj⟩ → box
⟨obj⟩ → ball
```

Draw the parse tree of the sentence **walk east pick box drop ball stop**. Hint: you can apply a recursive descent parsing technique (without actually programming a recursive descent parser). (10 points)

15. What is an *abstract syntax tree* and what is it used for? (explain) (7 points)

16. What is a *higher-order function*? (explain) (8 points)

17. Consider the LL(1) attribute grammar

$$\begin{array}{llll}
 \langle E \rangle & \rightarrow & \langle T \rangle \langle TT \rangle & TT.st := T.val; E.val := TT.val \\
 \langle T \rangle & \rightarrow & \text{unsigned\_int} & T.val = \text{unsigned\_int.val} \\
 \langle TT_1 \rangle & \rightarrow & + \langle T \rangle \langle TT_2 \rangle & TT_2.st := TT_1.st + T.val; TT_1.val := TT_2.val \\
 \langle TT \rangle & \rightarrow & \epsilon & TT.val := TT.st
 \end{array}$$

(a) Which attributes are synthesized or inherited? (mark the box) (4 points)

<i>Attribute</i>	<i>Synthesized</i>	<i>Inherited</i>
E.val		
T.val		
TT.st		
TT.val		

(b) Decorate the parse tree below with attributes and values. (10 points)