Midterm Test Solutions (Day section)
October 31, 2002

Duration: 50 minutes

Aids allowed: None

Weight: 20% of your course grade

This exam contains a total of 5 pages (including this one). Write your answers clearly in the spaces provided. Use the back pages for your rough work.

Surname: __________________________
First name: __________________________
Student #: __________________________

# 0: _____/ 1
# 1: _____/ 9
# 2: _____/ 4
# 3: _____/ 7
# 4: _____/ 5
# 5: _____/ 4
# 6: _____/ 10

TOTAL: _____/40

Good Luck!

Total Pages = 5
Question 0.  [1 mark]
Write your student number legibly in the space provided on every page of this test.

Question 1.  Grammars  [9 marks]

Part (a)  [2 marks]
Consider the following grammar:
\[<S> \rightarrow <G> \text{ op1 } <S> \mid <G>\]
\[<G> \rightarrow <G> \text{ op2 } <Z> \mid <Z>\]
\[<Z> \rightarrow <Z> \text{ op3 } <Z> \mid <Z> \text{ op4 } <M> \mid <M>\]
\[<M> \rightarrow x \mid y \mid ( <S> )\]

Give the associativity (left, right or neither) or the operators op1, op2, op3 and op4.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Associativity</th>
<th>Operator</th>
<th>Associativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>op1</td>
<td><em><strong>Right</strong></em>__</td>
<td>op3</td>
<td><em><strong>Neither</strong></em></td>
</tr>
<tr>
<td>op2</td>
<td><em><strong>Left</strong></em>___</td>
<td>op4</td>
<td><em><strong>Left</strong></em>___</td>
</tr>
</tbody>
</table>

Part (b)  [4 marks]
Consider the above grammar again. Which of the following strings are ambiguous? Mark the blank next to each string with either yes if it is ambiguous, or no if it is not ambiguous.

<table>
<thead>
<tr>
<th>Ambiguous?</th>
<th>Ambiguous?</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. <em><strong>Yes</strong></em> x op3 x op4 x</td>
<td>iii. <em><strong>No</strong></em>_ x op4 x op3 x</td>
</tr>
<tr>
<td>ii. <em><strong>Yes</strong></em> x op3 x op3 x</td>
<td>iv. <em><strong>No</strong></em>_ x op3 x op2 x</td>
</tr>
</tbody>
</table>

Part (c)  [3 marks]
Write a CFG in BNF for the following language: All strings of 0s and 1s that are palindromes (i.e., are the same whether read forward or backward) and contain an even number of 1s.

\[<S> \rightarrow 0 <S> 0 \mid 1 <S> 1 \mid 0 \mid \epsilon\]
Question 2. List Representation  [4 marks]

Draw a diagram showing Scheme's internal representation for the following expression:

\[(1 \ (3 \ ()) \ (4 \ . \ 5) \ ())\]

Question 3. Scheme Procedure  [7 marks]

Write a Scheme procedure (rem-dup lst) which returns a copy of lst with consecutive duplicate elements removed. Use eq? to test for equality.

For example,

(rem-dup ' (a b c c d a a a a)) returns (a b c d a).

(define rem-dup
  (lambda (lst)
    (cond ((null? lst) ())
      ((null? (cdr lst)) lst)
      ((eq? (car lst) (cadr lst)) (rem-dup (cdr lst)))
      (else (cons (car lst) (rem-dup (cdr lst))))))
  )
  )
Question 4. High-Order Procedures [5 marks]

Write a procedure (sums lst) which takes a list of lists of numbers and returns the sum of each element of lst. Use map and apply to write your procedure. You may not use recursion or eval. For example,

(sums '((1 2 3) (3 5 7 9 11))) returns (6 0 35).

; Pre: lst is a list of lists of numbers.
(define sums
    (lambda (lst)
        (map (lambda (x) (apply +) x) lst)
    )
)

Question 5. Parameter Passing [4 marks]

Consider the following code in some theoretical language:

int i, j, k;

subprogram p(int a, int b) {
    a := a + 2;
    b := b - 1;
    i := 6;
}

i := 1;
j := 2;
k := 3;

p(j, k);
print i, j, k;   --- print 1

p(j, i);         --- Note: p(j, i), not p(i, j)!
print i, j;      --- print 2

What is the output of this program if the parameter-passing mode of this language is pass by value-result?

print 1: i: 6 j: 4 k: 2

print 2: i: 5 j: 6
Question 6. Short Answers  [10 marks]

Part (a)  [1 mark]
Give one advantage of compilation over interpretation.

Two potential answers: Faster since you can compile once and execute many times; allows optimizations.

Part (b)  [1 mark]
Give one advantage of interpretation over compilation.

Three potential answers: Easier to provide meaningful error messages to the programmer; more flexible; allows rapid prototyping.

Part (c)  [1 mark]
Give one advantage of pseudo-compilation.

One potential answer: Platform independent.

Part (d)  [1 mark]
Name a key operation of the imperative programming paradigm.

Loop; assignment.

Part (e)  [2 marks]
Suppose you have a grammar that gives two different derivations for the same sentence. Is that grammar ambiguous? Circle the best answer:

Definitely yes  Definitely no  There is not enough information to tell

Part (f)  [2 marks]
With an ambiguous grammar, how many parse trees are there for any given sentence that is not in the language? Circle the best answer:

0  exactly 1  more than 1  1 or more

Part (g)  [2 marks]
What does (cons (car '((1) 2)) (cdr '3 (4))) return?

((1) (4))

Total Marks = 40