University of Toronto

CSC488S/CSC2107S Compilers and Interpreters **Winter 2012/2013**

Mid Term Test (20% of course mark) **March 7, 2013.**

5 questions on **2** pages. **100 marks total. 50 minutes total**
Open Book and Notes, Non-programmable calculators allowed, NO other electronic aids allowed
Answer all questions. WRITE LEGIBLY!
If you need to make any additional assumptions to answer a question, be sure to state those assumptions in your test booklet. The line numbers on the left side of programs and grammars are for reference only and not part of the program or grammar.

1. [20 marks] Financial quantities in North American notation are defined as:

- must begin with a leading dollar sign ($)
- an optional string of asterisks (e.g. ****) may follow the dollar sign
- there must be a non-empty string of decimal digits
- there may be an optional fractional part consisting of a decimal point and two decimal digits
- the string of digits to the left of the decimal point may contain a single zero
  otherwise the string of digits to the left of the decimal point may not start with a zero
- if there are more than three digits to the left of the decimal point, groups of three digits counting from the right must be separated by commas.
- Examples: $****3,456.78 $0.10 $20 $1,234,567.89

Write a regular expression (or a set of regular expressions) that recognize financial quantities in this notation.

2. [20 marks] Consider the grammar

1	G	→	S	$	
2	S	→	A	M	
3	M	→	S		
4		→	λ		
5	A	→	a	E	
6		→	b	A	A
7	B	→	b	E	
8		→	a	B	B
9	E	→	a	B	
10		→	b	A	
11		→	λ		

Where λ is the empty string
Is the grammar LL(1) ?
If it is LL(1) show the Predict Sets.
If it is not LL(1) identify a Predict Set conflict.

3. [20 marks] Consider the following union (i.e. variant record like) declaration:

```
1     union uTag : 1 .. 3 of
2     case 1:     x : int
3                 y : string( 3 )
4                 z : real
5     case 2:     a : array 1 .. 5 of boolean
6                 b : real
7                 c : record
8                       d : string( 1 )
9                       e : real
10                end record
11    case 3:     s : array 1 .. 9 of string( 5 )
12                t : real
13    end union
```

Assume the size and alignment factors for the basic data types:

type	align (bits)	size (bits)	type	align (bits)	size (bits)	type	align (bits)	size (bits)
1 .. 3	16	16	boolean	8	8	real	64	64
int	32	32	string(1)	8	8			

Where a string of length K is stored in K 8-bit bytes. Show the storage allocation that would be performed for this union type using the multi-level algorithm described in lecture. Give the relative location of each field in the union and show the fill that is required.

4. [20 marks] Describe semantic analysis checks that a Java compiler should perform on the program fragments listed below

Fragment A

```
1   void method() {
2       int I = 0 ;
3       while( I < 10 ) {
4           int J = 0 ;
5           I ++ ;
6       }
7       System.out.println( I ) ;
8   }
```

Fragment B

```
1   for( int K = 0 ; K < data.length ; K++ ) {
2       if( data[ K ] == target ) {
3           index = K ;
4           break ;
5       }
6   }
```

5. [20 marks] Show the symbol and type table entries that a typical compiler might produce for the union declaration in Question 3.