CSE 413 – Programming Languages
Autumn 2003

Final Exam

Max Points 50

Closed book, closed notes, no electronics.
Do your own work!

WARNING for Autumn 2004:

Last year's exam did not cover Scheme and Java, but this year's final will cover *all* course material (except Smalltalk). In particular, the following material will be covered but was not tested or not covered last year:

- -Scheme
- -Java
- -Logic programming languages

1. Consider the regular expression s = [A-Z][a-z]*(:[a-z]+)* **[3 Points]**

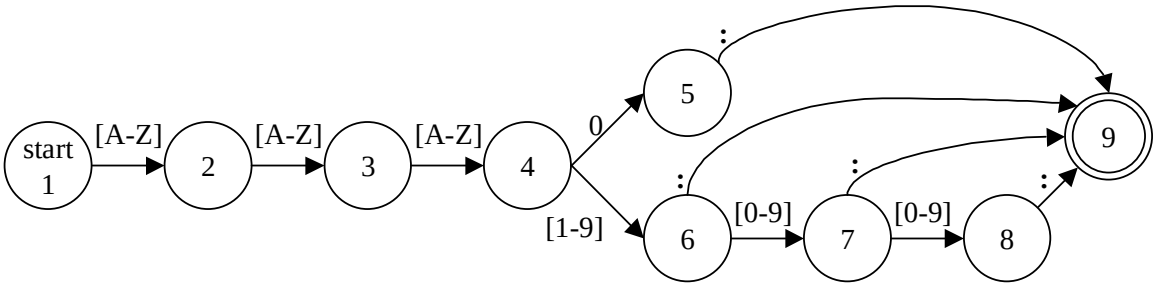
   Describe in English the language generated by s, ie L(s).

2. Consider the regular expression t = 0 | [12](0|1|2)* **[6 Points = 2 * 3]**
   a. What is the alphabet over which t is defined?

   b. Give two examples of strings that are members of L(t).

   c. Is L(t) a finite set or an infinite set?

3. Consider the following deterministic finite automaton. **[4 points = 2 * 2]**



a. Write down a regular expression that generates the language recognized by this DFA.

b. Write down the series of states that this DFA goes through for the following inputs and indicate whether or not the input is accepted.

Input string	**List of states by number**	**Accepted? Yes or No**
DUA0:		
MUC2		

4. Consider the regular expression r = [ch][ao][dt] **[9 points = 3 * 3]**

a. Describe in English the language generated by r.

b. Draw a DFA that accepts the language generated by r. Use the same symbology as I did in the previous problem to indicate states, transitions, and accept states.

c. Write a Java method that takes a String object as a parameter and returns a boolean value indicating either true, the String is accepted by the DFA, or false, the String is not accepted by the DFA. String instance methods that may be useful to you are:

int length()	returns the number of characters in this string.
char charAt(int idx)	returns the character at the given index in this string.
boolean equals(Object o)	returns true if "o" and this string are the same.

5. Consider the following language grammar G. There are two non-terminals defined in this grammar: *type* and *simple*. The start symbol is *type*. **id** is a terminal whose attribute is the string value of the associated identifier. **num** is a terminal whose attribute is the numeric value of the associated number. **dotdot** is the 2-character string "**..**".

type ::= *simple* | ↑**id**
| **array [** *simple* **] of** *type*

simple ::= **integer**
| **char**
| **num dotdot num**

a. What is the set of all terminals in grammar G? **[2 Points]**

b. Give an example of a string in L(G). **[2 Points]**

c. Show the parse tree generated by a top-down leftmost derivation of the following string.

array [integer] of ↑rocket **[4 Points]**

6. Consider the following grammar J. The start symbol is *program*. Only one main method is allowed, the one in mainClass.

Lexical issues

Integer literals are identified by the scanner and assigned a token type of *integerValue* with an associated numeric value attribute. Identifiers are identified by the scanner and assigned a token type of *id* with an associated string value attribute. The keywords are reserved and cannot be used as identifiers. End-of-line is not significant and is treated as whitespace.

Grammar J

program	→	mainClass | mainClass otherClass
mainClass	→	**class** id **{ public static void main (String** id **) {** statementList **}}**
otherClass	→	**class** id **{** methodDecl **}**
methodDecl	→	**public** type id **(**type id**) {**statementList **return** exp**; }**
type	→	**boolean** | **int** | id
statementList	→	statement statementList | ε
statement	→	{ statementList }
		| id = exp **;**
		| **if (** exp **)** statement **else** statement
exp	→	**true** | **false** | id | integerValue

a. Can we define class A, class B, and class C all in one program? Yes No **[1 Point]**

b. Can the main method have more than one argument? Yes No **[1 Point]**

c. Can methods other than main have a boolean argument? Yes No **[1 Point]**

d. What is the shortest valid program in this language L(J)? **[2 Points]**

e. Using grammar J, is there a syntax error in this program? Yes or No. If yes, identify it. **[2 Points]**

```
class A {
     public static void main ( String s ) {
          if (s) { a = 1; } else a = 0;
          b = true;
     }
}
class B {
     public boolean assert(A d) {
          return true;
     }
}
```

7. Consider the following Postscript code. Assume that the stack is empty before each snippet of code executes. Show what is on the stack after the code executes. **[3 Points =1 * 3]**

a. 3 2 3 add mul

b. /a 2 def

c. 1 2 3 4 exch pop

8. What do the following snippets of code draw on the page? **[4 Points = 2 * 2]**

a. newpath 100 100 moveto /w 50 def w w rlineto stroke

b. /inch {72 mul} def newpath 100 100 moveto true {0 1 inch} {5 inch 0 } ifelse rlineto stroke

9. Convert the following Java expressions to Postscript. You can assume that the variable names, procedure names and argument orders are the same in both languages. **[6 Points = 2* 3]**

a. Java: (2*PI)+1

Postscript:

b. Java: sin(idx*PI/10)

Postscript:

c. Java: moveto(50,idx*5)

Postscript: