University of Toronto
Department of Electrical and Computer Engineering

Midterm Examination

CSC467 - Compilers and Interpreters
Fall 2011

Print your name neatly in the space provided below.

Name:
ID Number:

Grade:

Question	Mark
1	
2	
3	
4	
5	
Total	

Problem 1 (10 marks): Consider the following grammar where { A, B, C, S} is the set of non-terminals, { x, y, z, EOI } is the set of terminals, and S is the start symbol.

```
S := ABC
A := xy | ε
B := y | ε
C := z | ε
```

a) Compute the FIRST set of all non-terminals.

b) Compute the FOLLOW set of all non-terminals.

Problem 2 (10 marks): The human gene sequence can be modeled as a string. According to Durbin et al in “Biological Sequence Analysis”, “*The human FMR-1 gene sequence contains a triplet repeat region in which the sequence CGG or AGG is repeated a number of times. The number of triplets is highly variable between individuals, and increased copy number is associated with fragile X syndrome, a genetic disease that causes mental retardation and other symptoms in one out of 2000 children*”.

The pattern is bracket by GCG and CTG, so we get the regular expression

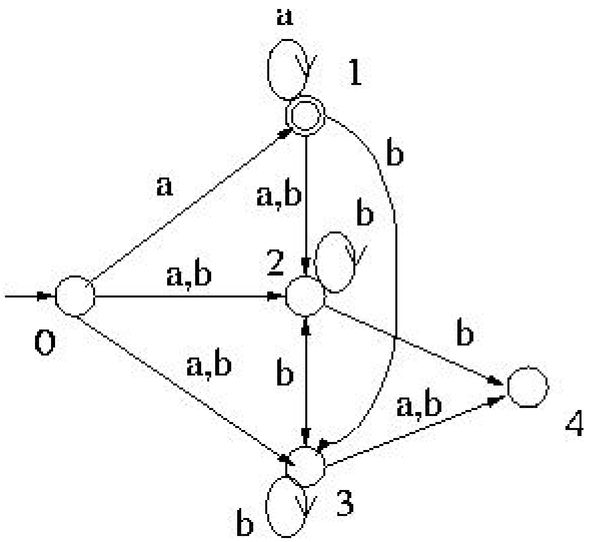
GCG (CGG | AGG)* CTG.

c) Construct a NFA to recognize the regular expression. Draw the NFA diagram, clearly mark the start and accepting state.

d) Construct a DFA to recognize the regular expression. Draw the DFA diagram, clearly mark the start and accepting state.

Problem 3 (5 marks): Write a regular expression to match all strings that contain exactly five vowels and the vowels are in alphabetical order.

Problem 4 (10 marks): Convert the following NFA to a DFA. Clearly mark each DFA state with the corresponding NFA states.



Problem 5 (15 marks): Javascript Object Notation (JSON) is a subset of JavaScript which deals with describing constant objects. Given its popularity, it has become a popular mechanism for data exchange among distributed web services.

An example of JSON expression is as follows:

[{ "foo" : 12, "bar" : "boom" }, 12, 13, “name”]

The grammar of JSON can be described as follows:

01 object := **{}** | **{** members **}**
02 members := pair | members **,** pair
03 pair := **string :** value
04 array := **[]** | **[** elements **]**
05 elements := value | elements **,** value
06 value := **string** | **number** | object | array | **true** | **false** | **null**

e) Modify the grammar so that it is suitable for top-down recursive descent parsing. Explain the reason why the modification is necessary.

f) Assume the lexical analysis function yylex() is available, which return the following token code:

```
typedef enum {
     TOKEN_STRING = 0,
     TOKEN_NUMBER = 1,
     TOKEN_TRUE = 2,
     TOKEN_FALSE = 3,
    TOKEN_LOBJECT    = ‘{‘,
    TOKEN_ROBJECT  = ‘}’,
    TOKEN_LLIST = ‘[‘,
    TOKEN_RLIST = ‘]’,
    TOKEN_COMMA = ‘,’,
    TOKEN_SEPERATOR = ‘:’
} TokenCode;
```

Write a top-down parser in C.