Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Faculty of Engineering, Mathematics and Science

School of Computer Science & Statistics

Integrated Computer Science Programme **Semester 2 2019**
Year 3 Annual Examinations

CS3071 – Compiler Design 1

??, ??????th Example 2019 **Unknown Hall** **??:?? – ??:??**

Prof. John Waldron

Instructions to Candidates:

Students must attempt all questions. Each question in Sections A-C is worth 3 marks. An incorrect answer in Sections A-C loses 20% of the correct mark. Marks for Section D are calculated based on the fraction of correct States identified in sequence. Enter your answers on the 3071 Optical Mark Recognition Answer Sheet provided. You may not start this examination until you are instructed to do so by the Invigilator. Exam Paper is not to be removed from venue.

Materials permitted for this examination:

Non-programmable calculators are permitted for this examination — please indicate the make and model of your calculator on each answer book used. To be accompanied by a CSU33071-1 Optical Mark Recognition Answer Sheet.

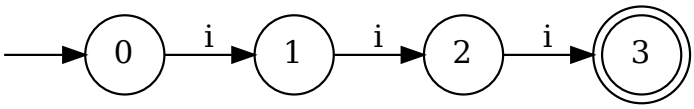
Section A

Q A.1

How many of the following 6 strings (whitespace and \n indicate a new string and are not part of the test data)

iiiiii i iiiii ii iiii iii

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below



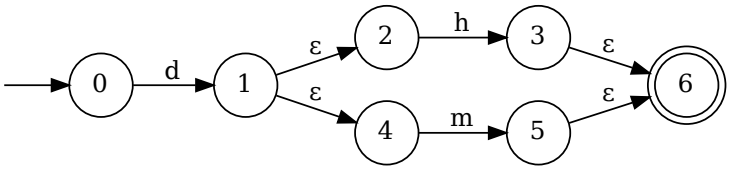
(A) 2 (B) 4 (C) 5 (D) 6 (E) 3 (F) OTHER (3 marks)

Q A.2

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

dmmmmd hhhmmmh ddddhhhhdddd dmm mmmmmmmmmm mhhhh dhmmm ddddmmmm mmmddddm ddddmmmmm mmmmhhhhh ddddd dmmmmh mdddhhhh mmmmddddhh

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below



Any string that contains 'dm' or 'dh'

(A) 12 (B) 9 (C) 8 (D) 10 (E) 2 (F) OTHER (3 marks)

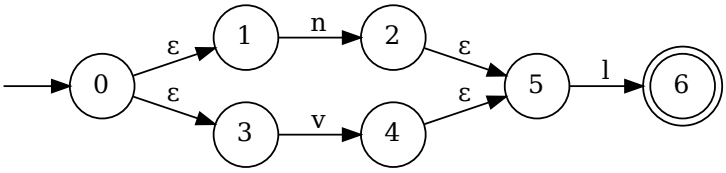
Q A.3

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

llnnnnn lllvll vvvvnnll vvvnnnnn nnlln nnnnvvnnn nnnnnnv lllnnn nnvvvvv llllll nnnnvvvvvvv lllvv lnnnlll vvvvl vvvvvvvvv

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below

any string that contains 'nl' or 'vl'



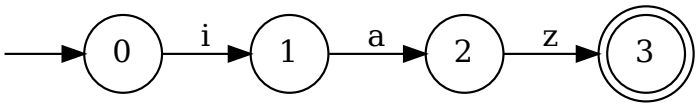
(A) 15 (B) 13 (C) 11 (D) 6 (E) 5 (F) OTHER (3 marks)

Q A.4

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

zzaazzz iaaaaa aiaaaa aaaiiii iiazzz aiiiiz zzzzza iaaaai iiiaaiii aaaaaaaaaa iaaaaz azzza iiiiizzz ziiiiii zzziiiiii

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below



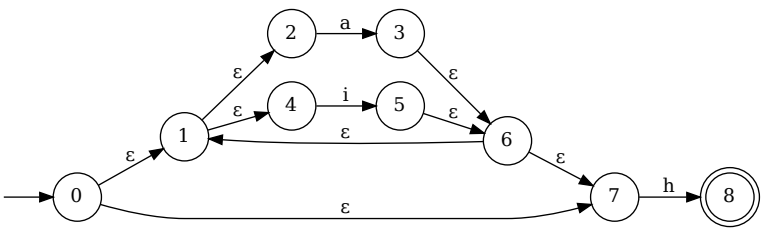
(A) 1 (B) 12 (C) 14 (D) 8 (E) 13 (F) OTHER (3 marks)

Q A.5

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

aiiihhh aaiiiihh aaiiih aaaaiiih aaaihh aaaaih aaaiiihh aihhh aihh aaih aih aaaaiihh aaaiiiihhh aiih aaihh

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below



any string that contains 'h' or 'ih' or 'ah'

(A) 3 (B) 9 (C) 10 (D) 11 (E) 15 (F) OTHER (3 marks)

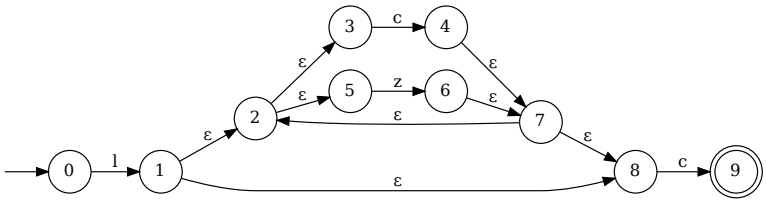
Q A.6

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

lllllllcc lcccczzz zzzlllzzzz cccczzzzzz cccclllzzz cccccccc
ccclllcc lllccczz lzzllll zzzzzzzzzz zzlcc lllllllc lllllll
llzzzllll lllllzzzz

are accepted, in part or whole, by the Thompson's construction nondeterministic finite state automaton shown below

'lc' or 'lzc' or 'lcc'



(A) 1 (B) 7 (C) 12 (D) 14 (E) 6 (F) OTHER (3 marks)

Section B

Q B.1

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

ffkff DDDkf DDDfkk DDDkkkD ffkkk ffffff kkkffk fDDD fffffDDD ffkk kfffff fkkkk kff kkkfffffff Dkkkkk

are matched at least once, in part or whole, by the Flex regular expression

k[a-z]D

(A) 2 (B) 12 (C) 9 (D) 1 (E) 14 (F) OTHER (3 marks)

Q B.2

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

SSSS hhhSSS hhhh hhSSS iiSSSS SSSiihh hSii hhhhSS hhiiSSS SSShhhhhh Siii SSii hhhSShh SSiiSSS hhhhhSS

are matched at least once, in part or whole, by the Flex regular expression

i[^a-z]S

(A) 3 (B) 10 (C) 9 (D) 5 (E) 15 (F) OTHER (3 marks)

string that contains i[NOT a-z]S

Q B.3

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

QQQQjjj QQjjjddd QQQjjj dddQQ dQQQQQ dddjQQQ dddjjjddd jjjQQQQ djjd jjjjQQ ddddQQQ jjjQQQjj jjddd jjjjjj jjjjjdd

are matched at least once, in part or whole, by the Flex regular expression

j[^A-Z]Q

(A) 9 (B) 14 (C) 7 (D) 8 (E) 3 (F) OTHER (3 marks)

Q B.4

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

mmmmmm VVmmmnnn nmmnnn mmmnnVVV nnnmmmmm VVVVVV nVVmm VVVVVVV mmmnVV mnVVV VVmmm mmnnVV nnnnnnmmm mmmmn nnnn

are matched at least once, in part or whole, by the Flex regular expression

nn[a-zA-Z][a-zA-Z]*m

(A) 6 (B) 12 (C) 14 (D) 9 (E) 2 (F) OTHER (3 marks)

Q B.5

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

WWWvve vvvvvvv eeeeWW eeeWWW vvvWWeee eeeWee vveeeee eeevvve WWee vvWee eeeWWWe evWW eeWWWW WWev Wvvee

are matched at least once, in part or whole, by the Flex regular expression

v[a-zA-Z][a-zA-Z]?ee

(A) 12 (B) 8 (C) 4 (D) 7 (E) 2 (F) OTHER (3 marks)

Q B.6

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

ssLL kksLL Lsss LLLLL kLLkk ssssk Lks kksss skks sLLL skkk ssLLL skLL LLskk ssLLk

are matched at least once, in part or whole, by the Flex regular expression

(sss|kk)

(A) 10 (B) 9 (C) 6 (D) 8 (E) 15 (F) OTHER (3 marks)

Q B.7

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

mmmmzz zmP zmmm mmmmmm zzzz Pmm zzzPP Pmzz PPPP zPPzz mPz mPmm PPzz zPP mmzzP

are matched at least once, in part or whole, by the Flex regular expression

([A-Z]{2,3}|[a-z]{4})

(A) 13 (B) 5 (C) 11 (D) 12 (E) 10 (F) OTHER (3 marks)

Q B.8

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

Gxxxvvv GGGvvx vvvvvG GGGvvv vGGGx GGGGxxx xxxxxxG vvvxvv xvvxx vvx xxGG xxxGG GGGxx GGvGG xxxxGGG

are matched at least once, in part or whole, by the Flex regular expression

..vG.

(A) 12 (B) 1 (C) 6 (D) 15 (E) 4 (F) OTHER (3 marks)

Q B.9

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

rXtt rrrrtt rttr ttrX XXrrXX tttXX Xtttt rtr rtXX tXXX ttXXX rrrrX rXr trrXX XXXt

are matched at least once, in part or whole, by the Flex regular expression

[a-z][A-Z]$

(A) 12 (B) 10 (C) 8 (D) 2 (E) 5 (F) OTHER (3 marks)

Q B.10

How many of the following 15 strings (whitespace and \n indicate a new string and are not part of the test data)

ssss Zzs Zssz ssZZZ zzZz ZZzzZ Zzzz zssz ssZz Zszz zZZss ZZzzss sszz zssZZ zzsz

are matched at least once, in part or whole, by the Flex regular expression

(z{2}|Z{1,2}|[A-M]+)$

(A) 2 (B) 9 (C) 10 (D) 6 (E) 8 (F) OTHER (3 marks)

Section C

Q C.1

How many of the following 7 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

rrr rr rrrrrr r rrrr KRVdNvZ sentence

are in the language defined by the Bison Context Free Grammar

```
%token r
%%
sentence: r | r sentence
;
```

(A) 6 (B) 3 (C) 1 (D) 7 (E) 5 (F) OTHER (3 marks)

Q C.2

How many of the following 8 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

h hhhhhh hhhhhhh hhhh sentence AvoINoH hhh hh

are in the language defined by the Bison Context Free Grammar

```
%token h
%%
sentence: h | sentence  h
;
```

(A) 2 (B) 8 (C) 6 (D) 4 (E) 3 (F) OTHER (3 marks)

Q C.3

How many of the following 7 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

ssssssUUUUU ssssssU sssssssUU sUU sentence sssUUU B7ZrlEQ

are in the language defined by the Bison Context Free Grammar

```
%token s U
%%
sentence: sub | sub sentence
sub: s | U
;
```

(A) 5 (B) 6 (C) 7 (D) 4 (E) 2 (F) OTHER (3 marks)

Q C.4

How many of the following 10 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

HHH nnnHH nnnnHHHH nnHH nnnnHHH nHH nnnn nnnnHH nnnHHH nHHH

are in the language defined by the Bison Context Free Grammar

```
%token n H
%%
sentence: n | H | n sentence
;
```

(A) 1 (B) 2 (C) 5 (D) 10 (E) 6 (F) OTHER (3 marks)

Q C.5

How many of the following 10 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

uuuHH uuuHHHH uHHH uuuuH H uuuuHH uuHH uuH uuuu uuuuHHHH

are in the language defined by the Bison Context Free Grammar

```
%token u H
%%
sentence: u | H | sentence u
;
```

(A) 5 (B) 2 (C) 9 (D) 7 (E) 10 (F) OTHER (3 marks)

Q C.6

How many of the following 10 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

eeL eeLLL eeeeLL eeLL eee eLLL eeeeL LLL eeeeLLL eeeLLL

are in the language defined by the Bison Context Free Grammar

```
%token e L
%%
sentence: e | L | L sentence
;
```

(A) 4 (B) 1 (C) 7 (D) 2 (E) 6 (F) OTHER (3 marks)

Q C.7

How many of the following 10 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

xx000 xx00 xxx0000 x000 00 x0 xxxx0 xxxx xx0000 x00

are in the language defined by the Bison Context Free Grammar

```
%token x O
%%
sentence: x | O | sentence O
;
```

(A) 3 (B) 4 (C) 2 (D) 10 (E) 7 (F) OTHER (3 marks)

Q C.8

How many of the following 5 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

cccccc;cccc;cc ccccccc;ccccc cccc;c; ccc;ccc ccc;cc;cc;ccc

are in the language defined by the Bison Context Free Grammar

```
%token c
%%
sentence: list | sentence list
list: listc ';'
listc: c | c listc
;
```

(A) 5 (B) 3 (C) 2 (D) 4 (E) 1 (F) OTHER (3 marks)

Q C.9

How many of the following 7 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

PP,P,PPPPP,PPPP PP,PPPP,PPPPPPPP PPPPPP,PPP,PPPPPP, PPPP,P,PPPPP, PPPPP,PPPPP,PPP, PPPPP,PPPP PPPPPP,PPP,

are in the language defined by the Bison Context Free Grammar

```
%token P
%%
sentence: listc | listc ',' sentence
listc: P | P listc
;
```

(A) 1 (B) 3 (C) 7 (D) 6 (E) 4 (F) OTHER (3 marks)

Q C.10

How many of the following 7 sentences (whitespace and \n indicate a new sentence and are not part of the test data)

b,bb,b,b, bbb,b,b,; bb,bb b,b,b,b,; bb,bbbb bbbb,b,; b,b,bb,bb

are in the language defined by the Bison Context Free Grammar

```
%token b
%%
sentence: commal ';'
commal: listc | listc ',' commal
listc: b | b listc
;
```

NONE END WITH JUST COLON

(A) 4 (B) 6 (C) 0 (D) 7 (E) 2 (F) OTHER (3 marks)

Section D

Q D.1

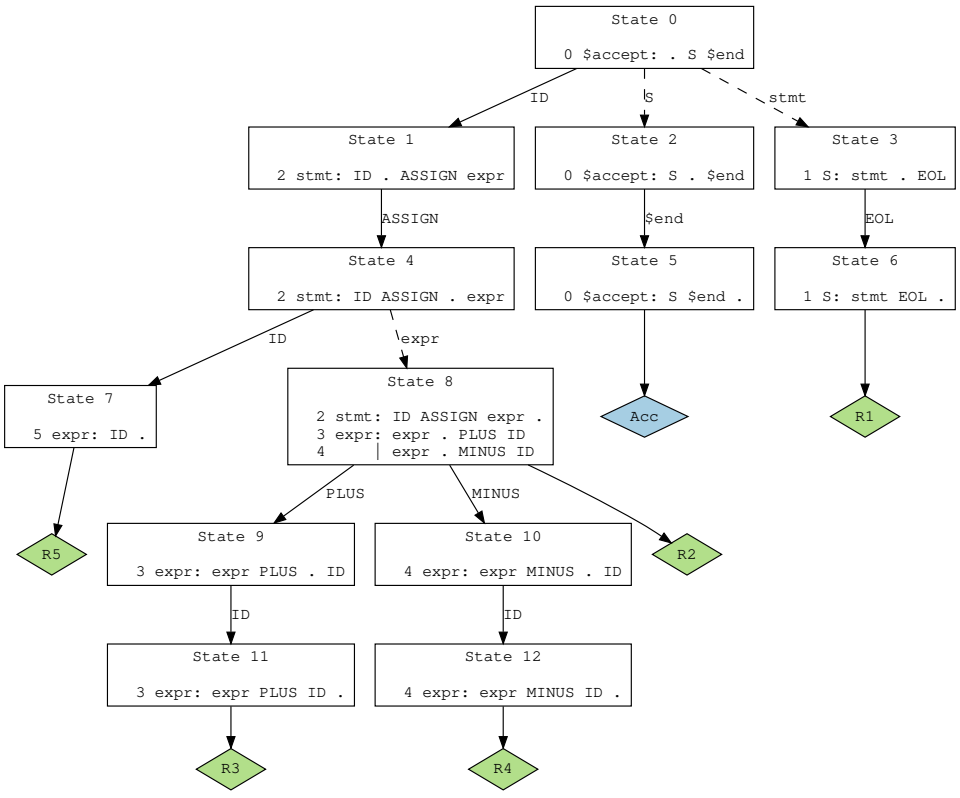
Given the following tokens

```
"+"     { return PLUS; }
"-"     { return MINUS; }
":="    { return ASSIGN; }
[a-z]   { yylval = yytext[0]; return ID; }
\n      { return EOL; }
```

and the following Bison Context Free Grammar

```
    0 $accept: S $end
    1 S: stmt EOL
    2 stmt: ID ASSIGN expr
    3 expr: expr PLUS ID
    4     | expr MINUS ID
    5     | ID
```

which generates the Bison Shift Reduce Parser



What sequence of states will the Bison Shift Reduce Parser go through parsing the sentence

```
g:=a+b+++\n
```

(11 marks)

Q D.2

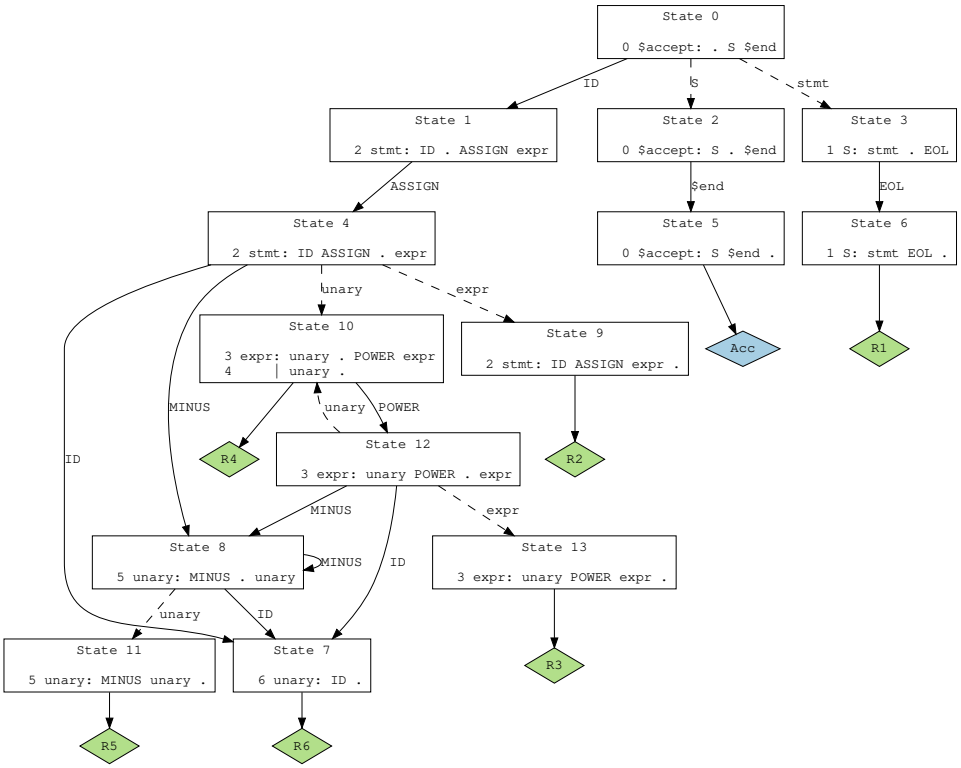
Given the following tokens

```
"^"     { return POWER; }
"-"     { return MINUS; }
":="    { return ASSIGN; }
[a-z]   { yylval = yytext[0]; return ID; }
\n      { return EOL; }
```

and the following Bison Context Free Grammar

```
    0 $accept: S $end
    1 S: stmt EOL
    2 stmt: ID ASSIGN expr
    3 expr: unary POWER expr
    4     | unary
    5 unary: MINUS unary
    6      | ID
```

which generates the Bison Shift Reduce Parser



What sequence of states will the Bison Shift Reduce Parser go through parsing the sentence

```
a:=b^c^d\n
```

(11 marks)