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 2023**
Year 3 Annual Examinations

CSU33071 – Compiler Design 1

??, ??????th Example 2023 **Unknown Hall** **??:?? – ??:??**

Prof. John Waldron

Instructions to Candidates:

Attempt all questions. Questions 1-26 are each worth 3 marks each. An incorrect answer loses 20% of the correct mark. Marks for Q27 are calculated based on the fraction of correct States identified in sequence. Enter your answers on the CSU33071 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 Optical Mark Recognition Answer Sheet.

In the following questions the test cases are listed on one or more lines separated by space characters. The space characters are not part of the test cases. Each test case will have a newline character \n appended at the end, which will be matched by a $ symbol in the regular expression.

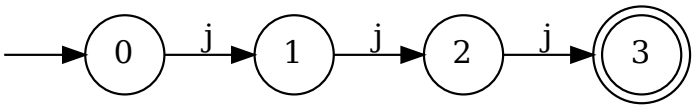
Note: zero is 0, uppercase letter is O, lowercase is o

Q 1.

How many of the following 6 strings

jjj j jjjjj jj jjjj jjjjjj

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



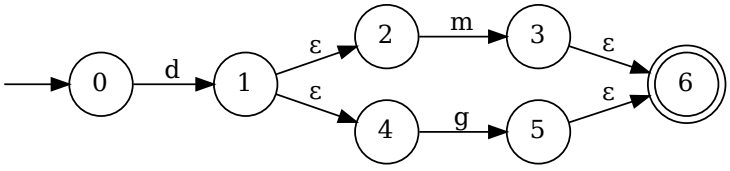
(A) 2 (B) 6 (C) 4 (D) 1 (E) 5 (F) OTHER

Q 2.

How many of the following 15 strings

gggggmm mmmgg mmmggggg mgggmmmm ddddddddddd mmmmmmm dmmgggg dddddg ddddgmm dddmmmgg ggggdddgg ddddmmmm gggggggg ddddddgg dddd

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



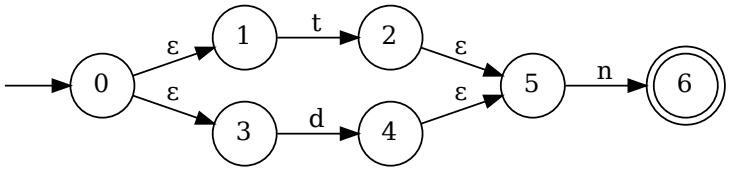
(A) 13 (B) 12 (C) 7 (D) 4 (E) 14 (F) OTHER

Q 3.

How many of the following 15 strings

ttddddtttt ddnnnn nttttnn dddddtt ttnnd ndddd tdddt tnnnnddddd
ttttddttt ddddd nnnn ttnt nntnnnn ttdd nnnnddddttt ddtttt

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



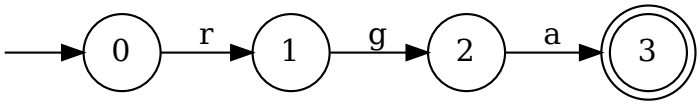
(A) 3 (B) 10 (C) 6 (D) 12 (E) 7 (F) OTHER

Q 4.

How many of the following 15 strings

aaaaaaa aaaargg grrrrrrr ggrrgg ggggggrrr rrrraaaggg aagaa
rrrrgggggg grrrrgg agaa raggg ggggagggg rrrrrrgggg rrraaa aaaaar

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



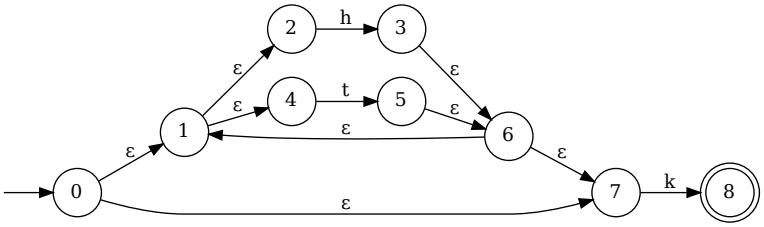
(A) 14 (B) 0 (C) 11 (D) 9 (E) 3 (F) OTHER

Q 5.

How many of the following 15 strings

hhtttk hhtkkkk hhtttkkk hhhttk hhhhtk hhhtkkk httkkk hhhtttkk
hhhhtttttkk hhttttk hhhtkkkk hhhhttkk hhhttkk hhhhtttkkkk httkkkk

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



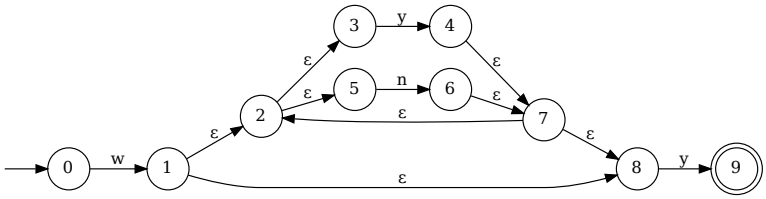
(A) 2 (B) 15 (C) 10 (D) 4 (E) 6 (F) OTHER

Q 6.

How many of the following 15 strings

yyyywww yyyyyywwww nwwwnnnn www nnnnnyyyy wwwwwnnnn nnnnnnnyyyy
wwwwyyyyyyy yyyynnw yyyywwwwnnnn nwwwww ywwwwww nnnnnyyy nnnwwwnnnn
wwwwwnn

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



(A) 3 (B) 11 (C) 14 (D) 1 (E) 12 (F) OTHER

Q 7.

How many of the following 6 strings

P PP PPPPPP PPP PPPPP PPPP

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

PPP

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

Q 8.

How many of the following 15 strings

nBBBn nnnnnnn ccccccc BBBBBB ncccc nBB cccccc BBBnnBB ccnnnn cccBnn
cccBBBc nnnBB cccccccc cnnnnn Bcccc

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

n[^a-z]B

(A) 15 (B) 2 (C) 4 (D) 1 (E) 3 (F) OTHER

Q 9.

How many of the following 15 strings

xxRv RRRRR vvvRRRR RRRRx Rxxvv Rxxv RRRvvRR vvvxRRR vxxR xRRRRRR
RRRvx RRRvvvxxx xxxxvv vvRRRR vvRxxx

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

v[a-zA-Z]R

(A) 11 (B) 5 (C) 12 (D) 14 (E) 6 (F) OTHER

Q 10.

How many of the following 15 strings

jjjjjjjj RRRwRRR RRRRjjj wwjR wwwwwRRR RRRRRR wwww RRRww wwwRRRjj
jwww jjjjRR wwwRRjj Rjww wwjjjjjj jRRRw

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

jj[a-zA-Z][a-zA-Z]+w

(A) 4 (B) 11 (C) 2 (D) 5 (E) 0 (F) OTHER

Q 11.

How many of the following 15 strings

JJJeee egggggg JJJeegg ggggee geee ggggg eeeggge JJJgJJ eeJggg
eeeee JJJJJ JJJJJJ eeeeeg ggeeeJJJ JJJJ

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

e[a-zA-Z]{2}gg

(A) 14 (B) 1 (C) 13 (D) 3 (E) 11 (F) OTHER

Q 12.

How many of the following 15 strings

nnntt nCCCC tCCCnnn nnttttt tCCCC nttnnn ttCC nnnCC tnnnnn CCC
CCCtttnn CttC CCCCttt CCtC CCCCt

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

n[a-zA-Z]{1,2}tt

(A) 2 (B) 3 (C) 13 (D) 6 (E) 10 (F) OTHER

Q 13.

How many of the following 15 strings

xxxx ffxC fffCC fCCC CxCC ffCff CCxxf xxffxx xfx ffxff xxfff xCCff
fxxx xffff xCCx

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

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

(A) 12 (B) 13 (C) 7 (D) 9 (E) 4 (F) OTHER

Q 14.

How many of the following 15 strings

JJJJ JJJkzzz kzk kkkJJJz zzzkkkk zzkkkkk zzJJJJ kkkkz JJkJJ kJzzz
kkkzzkk zzzzzkk JJJkkkJ JJJJJ kkkJJkk

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

kk.

(A) 12 (B) 14 (C) 7 (D) 6 (E) 9 (F) OTHER

Q 15.

How many of the following 15 strings

ddz zzd zzz zdE EzE EEd zEE zzE zEz dEz Edd EEE zdd Ezd Ezz

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

^[a-z]

(A) 7 (B) 14 (C) 8 (D) 6 (E) 9 (F) OTHER

Q 16.

How many of the following 15 strings

oooo OOwOO OOwwOO Ooow wooo oOOww ooooww ooOw wOOOO owwo owwOO
OwwOO OOOw www ooOoo

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

(o{2}|O{1,2}|[A-M]+)$

(A) 3 (B) 8 (C) 13 (D) 12 (E) 15 (F) OTHER

Q 17.

How many of the following 9 sentences

b bbbbbbbb zs3ZmXc bbbbbb bbbbb bb bbbb bbbbbbb sentence

are in the language defined by the Bison Context Free Grammar

```
%token b
%%
sentence: b | b sentence
;
```

(A) 5 (B) 9 (C) 6 (D) 7 (E) 1 (F) OTHER (3 marks)

Q 18.

How many of the following 8 sentences

WWWWW WW WWWWWW WWWW WWWWWWW NSsg0EK W sentence

are in the language defined by the Bison Context Free Grammar

```
%token W
%%
sentence: W | sentence  W
;
```

(A) 1 (B) 6 (C) 5 (D) 3 (E) 4 (F) OTHER (3 marks)

Q 19.

How many of the following 7 sentences

sentence L3kcIUT jjjjFFFFFF jjjjjjFF jFFFFF jjjjjjjFFFFF jjjFF

are in the language defined by the Bison Context Free Grammar

```
%token j F
%%
sentence: sub | sub sentence
sub: j | F
;
```

(A) 3 (B) 1 (C) 7 (D) 5 (E) 2 (F) OTHER (3 marks)

Q 20.

How many of the following 10 sentences

dddEEEE ddE ddd ddddEEEE ddddE EE ddddEEE ddEE dddE dEEE

are in the language defined by the Bison Context Free Grammar

```
%token d E
%%
sentence: d | E | d sentence
;
```

(A) 4 (B) 3 (C) 8 (D) 5 (E) 9 (F) OTHER (3 marks)

Q 21.

How many of the following 10 sentences

rrrrRR rR rrRRR rrrR rrrrRRR rrrrRRRR rRRR rrrRR RR r

are in the language defined by the Bison Context Free Grammar

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

(A) 7 (B) 4 (C) 2 (D) 10 (E) 1 (F) OTHER (3 marks)

Q 22.

How many of the following 10 sentences

xxxMMMM xxx xxM xM MMM xxxxMMMM xMM xxMMM xxxxMMM xxMM

are in the language defined by the Bison Context Free Grammar

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

(A) 4 (B) 8 (C) 1 (D) 9 (E) 7 (F) OTHER (3 marks)

Q 23.

How many of the following 10 sentences

xxVV VV xxVVVV xxxxVVV xVV xxxx xxVVV xxxxVV xxxV xxxVVVV

are in the language defined by the Bison Context Free Grammar

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

(A) 2 (B) 4 (C) 9 (D) 1 (E) 5 (F) OTHER (3 marks)

Q 24.

How many of the following 5 sentences

uuuuuuuuuuu uuuu;u;uuu; uuuu;u;uu;u; u;uuuuu;uuu; uuu;uuuuuu;

are in the language defined by the Bison Context Free Grammar

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

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

Q 25.

How many of the following 7 sentences

qqqqq q,qq,q,q qq,q,q q,qq,q,q, qqqq,q, qq,q,q qqqq

are in the language defined by the Bison Context Free Grammar

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

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

Q 26.

How many of the following 5 sentences

LL,LL,; L,LLL,L,; L,LL; LL,L,L, LLL,L

are in the language defined by the Bison Context Free Grammar

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

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

Q 27.

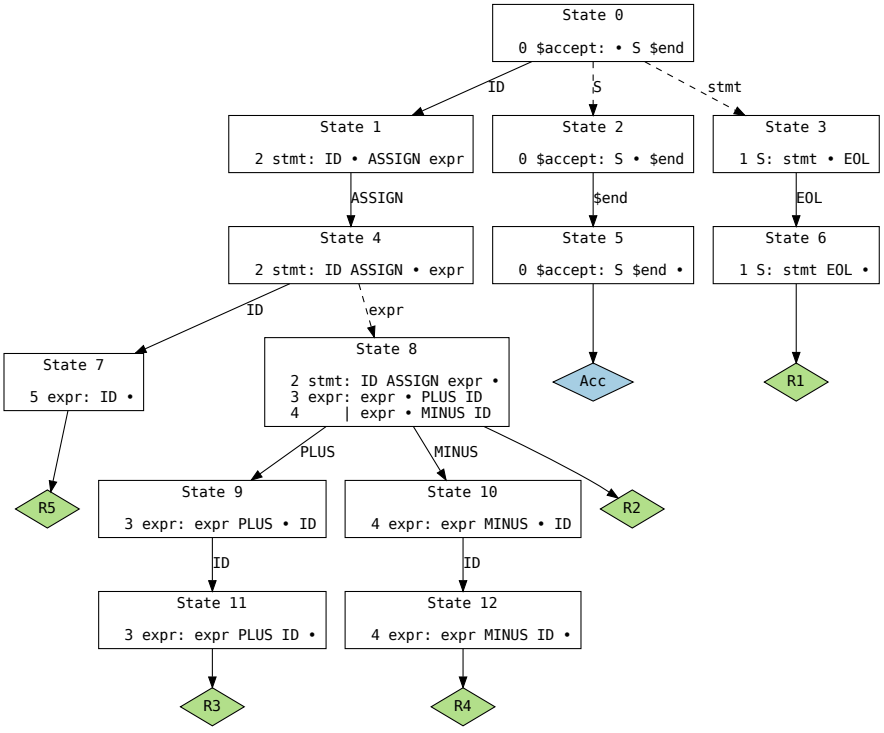
Given the following tokens

```
"+"     { 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
```

(22 marks)