Hamzah Malik, ID: ACSF375

Theory of Computation Coursework – <u>ACSF375</u>

Questions answered: A1 and B1

A1) a.

Theory of Computation Coursework HAMZAH MALIK - ACSF375

A1) a. 1. $x = [i(3)/2] = 1.5 = 1$ $x = 1$ ID: ACSF375

2. $y = [x(1) + 3] \bmod 5 = 4$ $y = 4$

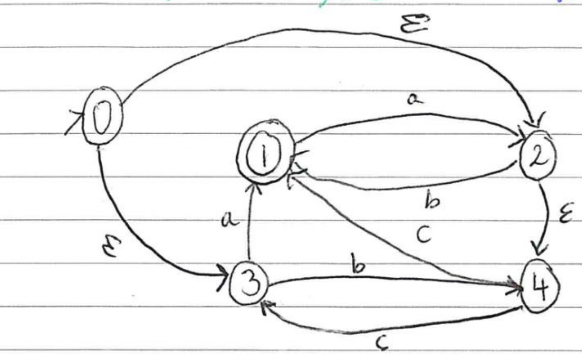
3. $z = [i(3)/5] + 1 = 1.6 = 1$ $z = 1$ $i = 3$ $j = 7$ $k = 5$

4. $u = [j(7)/5] + 3 = 4.4 = 4$ $u = 4$

5. $v = [k(5)/5] + 1 = 2$ $v = 2$

6. $w = 5 - v(2) = 3$ $w = 3$

a.



A1) b.

b.) Create our transition table

State	a	b	c	ε
0	ε	ε	ε	2, 3
1	2	ε	ε	ε
2	ε	1	ε	4
3	1	4	ε	ε
4	ε	ε	1, 3	ε

Initial ~~value~~ state = 0

Accept state = 1

My empty transitions from start:

$\boxed{0 \to 2 \quad 0 \to 2 \to 4 \quad 0 \to 3}$

Create our new transition table:

Type of state	New state	a	b	c
Start	{0,2,3,4}	{1}	{1,4}	{1,3}
Accept	{1}	{2,4}	∅	∅
Accept	{1,4}	{2,4}	∅	{1,3}
Accept	{1,3}	{1,2,4}	{4}	∅
	{2,4}	∅	{1}	{1,3}
Accept	{1,2,4}	{2,4}	{1}	{1,3}
	{4}	∅	∅	{1,3}
Empty	{∅}	∅	∅	∅

Hamzah Malik, ID: ACSF375

Renaming our states

HAMZAH MALIK

Type of state	new state	rename
Start	{0,2,3,4}	{5}
Accept	{1}	{6}
Accept	{1,4}	{7}
Accept	{1,3}	{8}
	{2,4}	{9}
Accept	{1,2,4}	{10}
	{4}	{11}
Empty	{∅}	{12}

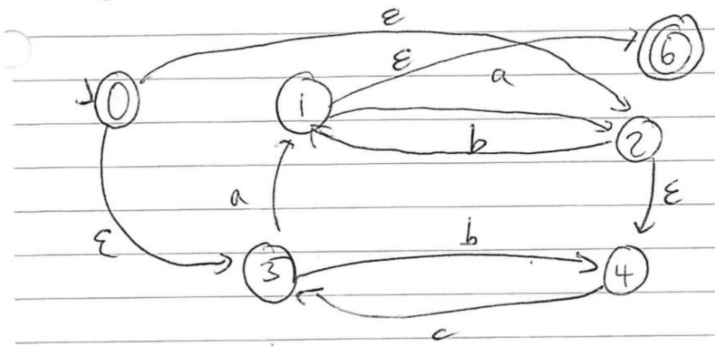
Type of state	New State	a	b	c
start	{5}	{6}	{7}	{8}
Accept	{6}	{9}	{12}	{12}
Accept	{7}	{9}	{12}	{8}
Accept	{8}	{10}	{11}	{12}
	{9}	{12}	{6}	{8}
Accept	{10}	{9}	{6}	{8}
	{11}	{12}	{12}	{8}
Empty	{12}	{12}	{12}	{12}

A1) c.

Creating a new accept state for my initial diagram.

HAMZAH MALIK- ACSF375

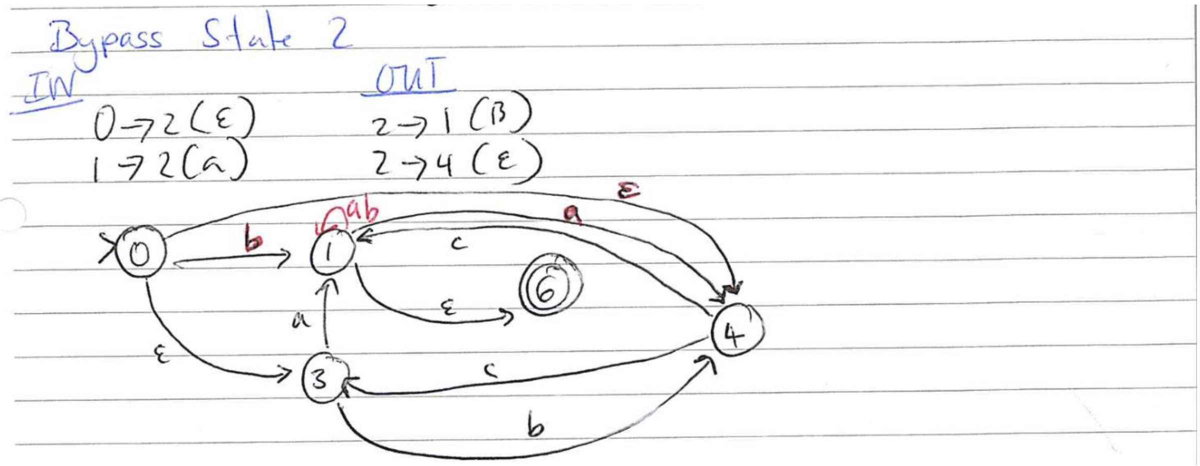
1a)c) Create new accept state



My new accept state from my initial diagram in part a is now 6 instead of 1. Note a new start state is not needed as there are no incoming transitions from node 0.

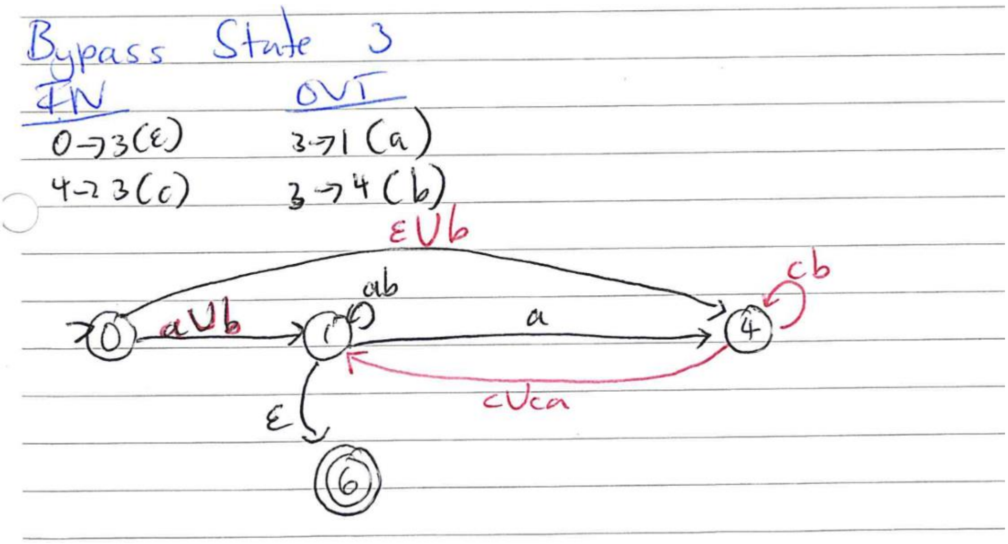
Bypass State 2

I now bypass State 2 and label the incoming transitions and outgoing transitions. This gives a total of 2x2 transitions which means 4 new transitions – these are coloured in red in the diagram below.

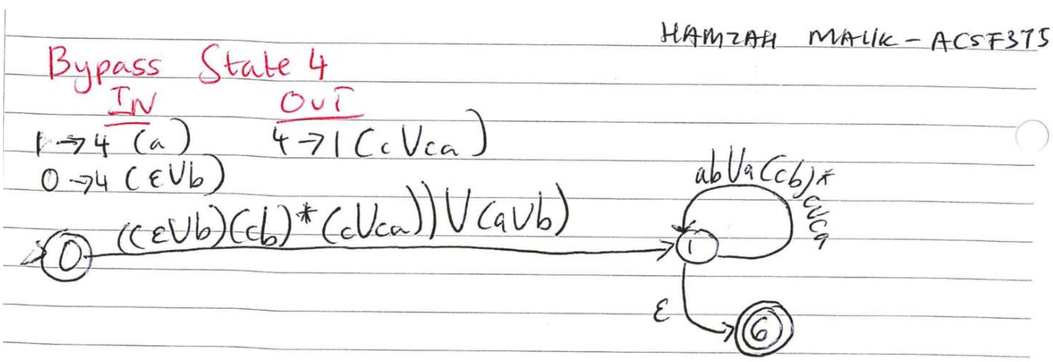


I have now chosen to bypass State 3. This also has four new transitions (2 in, 2 out) and labelled below in red.

Note: I have applied the sum of edges to transitions where necessary.



Bypassing State 4.



Bypassing State 1

Hamzah Malik, ID: ACSF375

Bypass State 1

IN OUT

((εUb)(cb)*...

$$0 \xrightarrow{(((\varepsilon \cup b)(cb)^*(c \cup ca)) \cup (a \cup b))((ab) \cup a(cb)^*c \cup a)^*} 6$$

Final

↳ (((εUb)(cb)*(cUca)) U (aUb))((ab)Ua(cb)*cUa)*

Our final regular expression from this diagram using Kleenes Theorem is:

(((ØUb)(cb)*(cUca))U(aUb))((ab)Ua(cb)*cUa)*

Hamzah Malik, ID: ACSF375

B1) a.

HAMZAH MALIK - ACSF375

B1) a) 1. First introduce our new start production rule.

- $S0 \rightarrow S$
- $S \rightarrow BDE \mid aE \mid b$
- $B \rightarrow BC \mid \varepsilon$
- $C \rightarrow b$
- $D \rightarrow SC \mid \varepsilon$
- $E \rightarrow BD \mid b$

2. Now we must identify the productions that lead to null and remove these null productions.

- $B \rightarrow \varepsilon \mid BC \mid C$
- $D \rightarrow \varepsilon \mid SC \mid C$
- $E \rightarrow BD \mid B \mid D \mid \varepsilon$
- $E \rightarrow BDE \mid BD \mid BE \mid DE \mid B \mid D \mid E \mid a \mid \varepsilon$
- $S0 \rightarrow S \mid \varepsilon$

↳ Now, we remove our null paths:

- $S0 \rightarrow S$
- $S \rightarrow BDE \mid aE \mid b \mid BD \mid BE \mid DE \mid B \mid D \mid E \mid a$
- $B \rightarrow BC \mid C$
- $C \rightarrow b$
- $D \rightarrow SC \mid C$
- $E \rightarrow BD \mid b \mid B \mid D$

3. Remove unit productions -> first identify these:

- S0 -> S
- S -> B | D | E
- B -> C
- D -> C
- E -> B | D

now these values are replaced.

- S0 -> BDE | aE | b | BD | BE | DE | BC | SC | a
- S -> BDE | aE | b | BD | BE | DE | BC | SC | a
- B -> BC | b
- C -> b
- D -> SC | b
- E -> BD | b | BC | SC

HAMZAH MALIK - ACSF 375

4. We have to remove the productions containing 2+ symbols.
These are:
- S0 -> BDE
- S -> BDE

We introduce a new production rule for this case which we call Y
↳ • Y -> a

This transforms our CFG to the following:

- S0 -> BY | aE | b | BD | BE | DE | BC | SC | a
- S -> BY | aE | b | BD | BE | DE | BC | SC | a
- B -> BC | b
- C -> b
- D -> SC | b
- E -> BD | b | BC | SC

↳ • Y -> DE ->this is our new production rule

Hamzah Malik, ID: ACSF375

5. Lastly we remove our mixed productions and replace emptys removed.
The only mixed productions are:

- $S0 \rightarrow aE$
- $S \rightarrow aE$ → both mix terminals and non-terminals

To fix this, we introduce a new production rule for the TERMINAL symbol.

- $Z \rightarrow a$

We also add an empty (ε) to S0 to replace the emptys removed.

CNF OF OUR CFG:

$S0 \rightarrow BY \mid ZE \mid BD \mid BE \mid DE \mid BC \mid SC \mid a \mid b \mid \varepsilon$
$S \rightarrow BY \mid ZE \mid BD \mid BE \mid DE \mid BC \mid SC \mid a \mid b$
$B \rightarrow BC \mid b$
$C \rightarrow b$
$D \rightarrow SC \mid b$
$E \rightarrow BD \mid b \mid BC \mid SC$
$Y \rightarrow DE$
$Z \rightarrow a$

Hamzah Malik, ID: ACSF375

B1) b.

HAMZAH MALIK - ACSF375

(S0, ε, ε), (f, S0)
(f, ε, S0), (f, B~~X~~)
(f, ε, S0), (f, ZE)
(f, ε, S0), (f, BD)
(f, ε, S0), (f, BE)
(f, ε, S0), (f, DE)
(f, ε, S0), (f, BC)
(f, ε, S0), (f, SC)
(f, ε, S0), (f, a)
(f, ε, S0), (f, b)
(f, ε, S0), (f, ε)

(f, ε, S), (f, B~~X~~)
(f, ε, S), (f, ZE)
(f, ε, S), (f, BD)
(f, ε, S), (f, BE)
(f, ε, S), (f, DE)
(f, ε, S), (f, BC)
(f, ε, S), (f, SC)
(f, ε, S), (f, a)
(f, ε, S), (f, b)

(f, ε, B), (f, BC)
(f, ε, B), (f, b)
(f, ε, C), (f, b)

(f, ε, D), (f, SC)
(f, ε, D), (f, b)

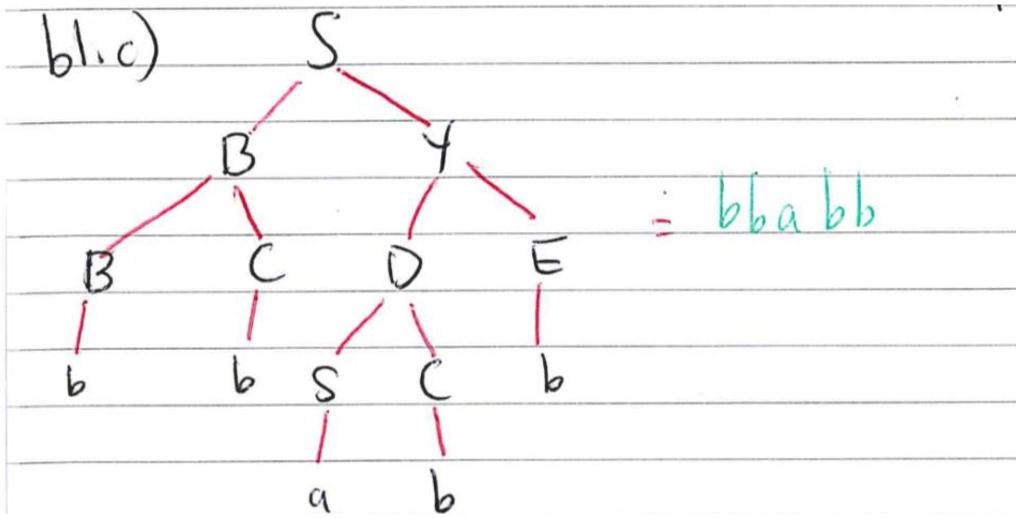
(f, ε, E), (f, BD)
(f, ε, E), (f, b)
(f, ε, E), (f, BC)
(f, ε, E), (f, SC)

(f, ε, Y), (f, DE)

(f, ε, Z), (f, a)

(f, a, a), (f, ε)
(f, b, b), f, ε)

B1) c.



B1) d.

Current State	Input Tape	Stack
SO	bbabb	∅
F	bbabb	SO
f	bbabb	BY
f	bbabb	BCY
f	bbabb	bCY
f	bbabb	CY
f	bbabb	bY
f	bbabb	Y
f	bbabb	DE
f	bbabb	SCE
f	bbabb	aCE
f	bbabb	CE
f	bbabb	bE
f	bbabb	E
f	bbabb	b
F	bbabb	ε