National University of Computer and Emerging Sciences
Lahore Campus

Compiler Construction (CS4031)

Sessional-II Exam

Date: April 5th 2024

Course Instructor(s)

Dr. Faisal Aslam

Total Time (Hrs):	**1**
Total Marks:	**30**
Total Questions:	**4**

____________ Roll No

____________ Section

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Do not write below this line

Attempt all the questions.
Using calculator is not allowed
Cheat sheet(s) are not allowed

1. **SLR Parsing**: Given CFG:

[3+2+3+1=9 Marks]

$$S \rightarrow X \mid ay$$
$$X \rightarrow xXy \mid Y$$
$$Y \rightarrow a$$

(a) Create LR(0) automaton

(b) Specify any conflicts in LR(0) automaton and their types

(c) Create predictive parsing table for SLR.

(d) Is the grammar SLR or not? Give reason(s).

a)

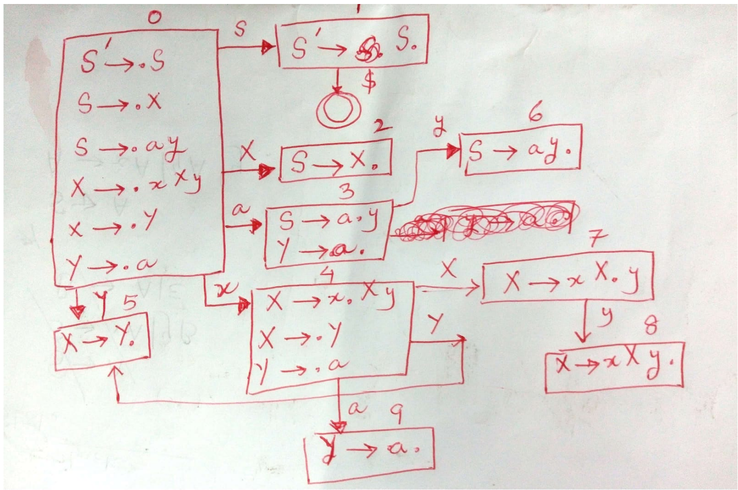
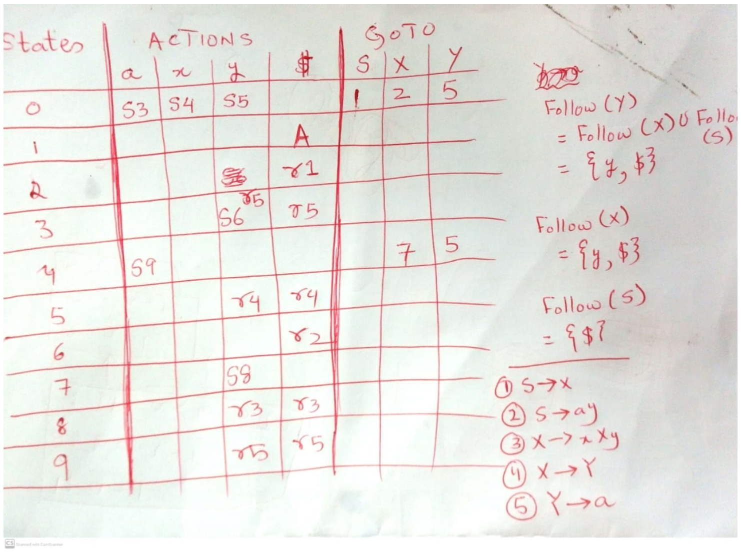


Figure 1: **IMPORTANT NOTE:** In the diagram I4 is incorrect. It should have production $x \rightarrow .xXy$ and a self-loop on small x. Otherwise, it is correct. I am too lazy to recreate it. Sorry about it.

b) There is a shift-reduce conflict in State-3

c)

d) The grammar is not SLR as the conflict remains in the parsing table.



States	ACTIONS				GOTO		
	a	x	y	$	S	X	Y
0	S3	S4	S5		1	2	5
1				A			
2				r1			
3			r5 S6	r5			
4	S9					7	5
5			r4	r4			
6				r2			
7			S8				
8			r3	r3			
9			r5	r5			

Follow (Y)
= Follow (X) ∪ Follow (S)
= {y, $}

Follow (X)
= {y, $}

Follow (S)
= {$}

① S → X
② S → ay
③ X → xXy
④ X → Y
⑤ Y → a

2. **LALR Parsing**: Given CFG:

[3+2+3+4=12 Marks]

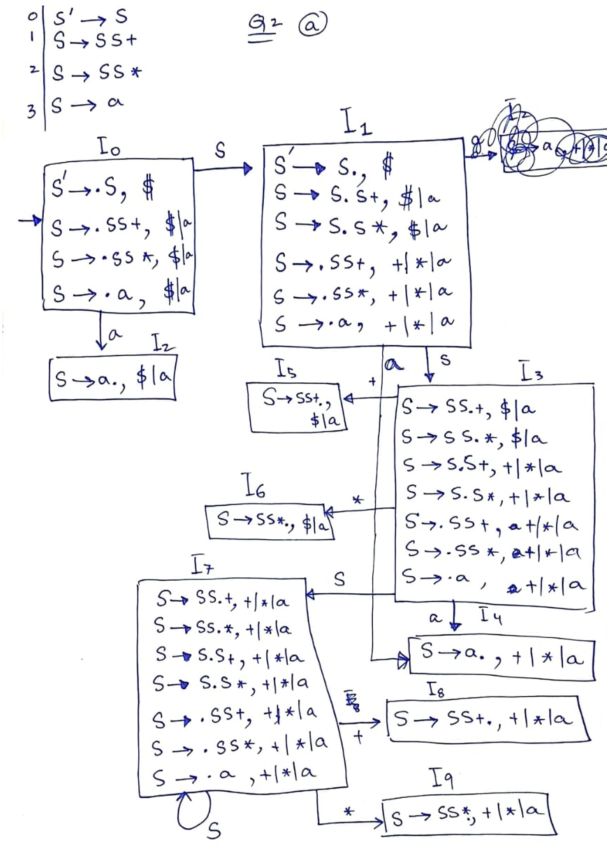
$$S \to SS+ \mid SS* \mid a$$

(a) Create LR(1) automaton

(b) Create predictive Parsing table for CLR

(c) Create predictive Parsing table for LALR

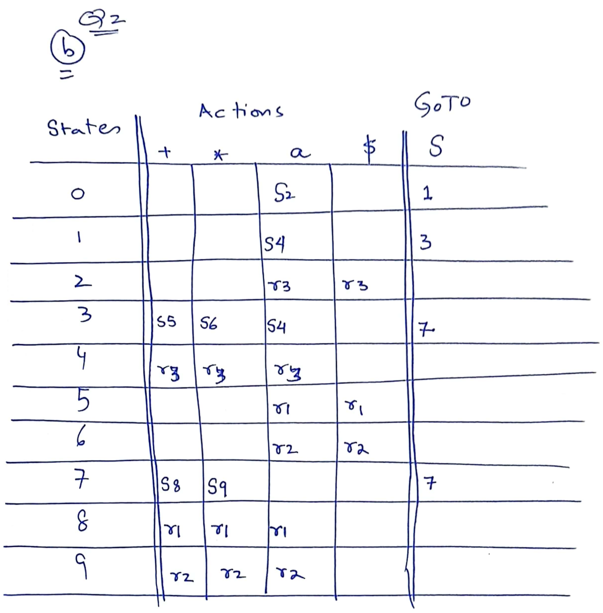
(d) Use LARL parsing algorithm and create parse tree for string $aaa*+$. Must show the data structures and all the steps.



```
1: a = 1
2: b = a + 1
3: IF a < b GOTO 7
4: a = a + b
5: c = a + 1
6: k = 5
7: GOTO 10
8: b = b + 1
9: c = c + 1
10: IF c < 10 GOTO 4
11: a = 0
12: b = 0
```

3. Create Control Flow Graph of the three address code given above.

[4 Marks]



Q2

(b)

	Actions				GoTO
States	+	*	a	$	S
0			S2		1
1			S4		3
2			r3	r3	
3	S5	S6	S4		7
4	r3	r3	r3		
5			r1	r1	
6			r2	r2	
7	S8	S9			7
8	r1	r1	r1		
9	r2	r2	r2		

```
x = 9 + 2
y = sin(90) + cos(90)
t1 = x + y
t2 = t1 * 2
t3 = m
t4 = t3 + k
a = t3 * 16
b = z-(-b)
r = m + k
```

ⓒ Q2

States to combine

1) I_9 & I_6

2) I_8 & I_5

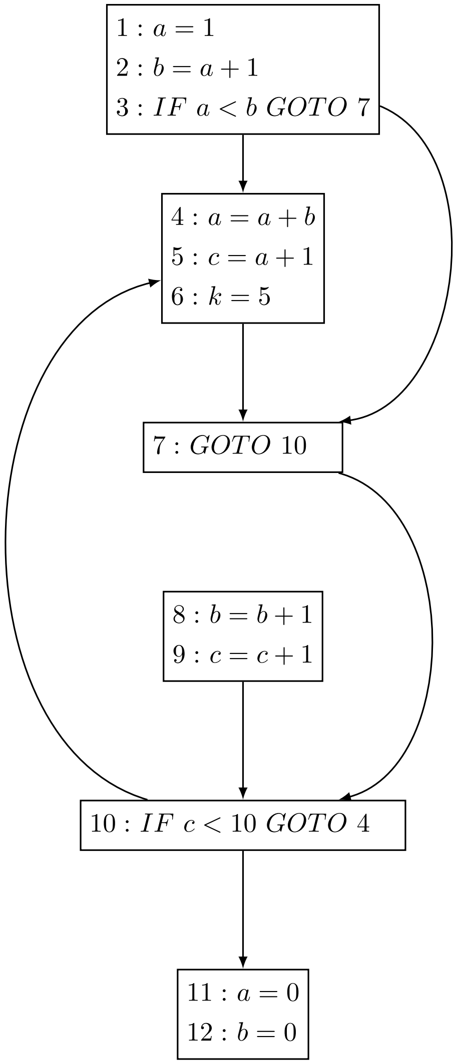
3) I_4 & I_2

4) I_7 & I_3

	Actions				GoTo
States	+	*	a	$	S
0			S2		1
1			S4		3
24	r3	r3	r3	r3	
37	S58	S69	S4		7
58	r1	r1	r1	r1	
69	r2	r2	r2	r2	

4. Given the above basic block, perform 1) constant folding, 2) copy/constant propagation, 3) common subexpression elimination, and 4) arithmetic simplification optimizations. Clearly label each optimization to show your working.

[**5 Marks**]



$1: a = 1$
$2: b = a + 1$
$3: \mathit{IF}\ a < b\ \mathit{GOTO}\ 7$

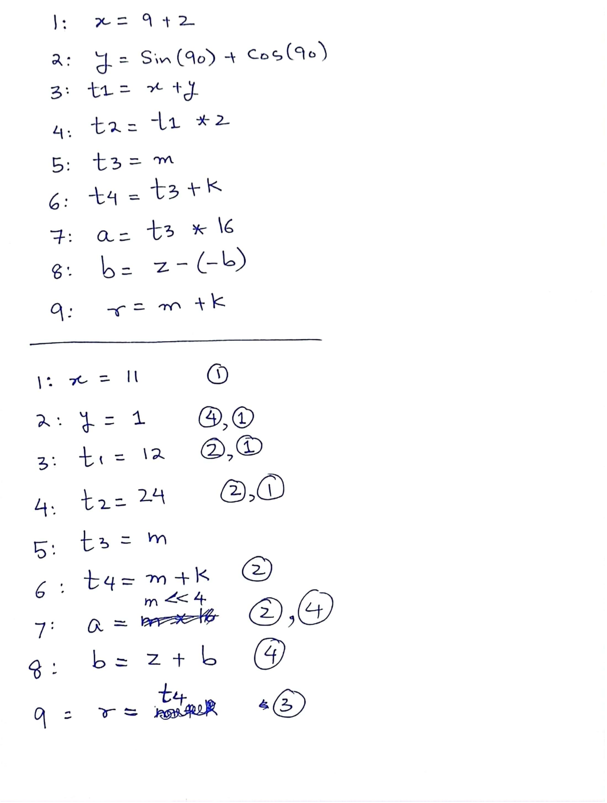
$4: a = a + b$
$5: c = a + 1$
$6: k = 5$

$7: \mathit{GOTO}\ 10$

$8: b = b + 1$
$9: c = c + 1$

$10: \mathit{IF}\ c < 10\ \mathit{GOTO}\ 4$

$11: a = 0$
$12: b = 0$



1: $x = 9 + 2$

2: $y = \sin(90) + \cos(90)$

3: $t1 = x + y$

4: $t2 = t1 * 2$

5: $t3 = m$

6: $t4 = t3 + k$

7: $a = t3 * 16$

8: $b = z - (-b)$

9: $r = m + k$

1: $x = 11$ ①

2: $y = 1$ ④, ①

3: $t_1 = 12$ ②, ①

4: $t_2 = 24$ ②, ①

5: $t_3 = m$

6: $t4 = m + k$ ②

7: $a = \overset{m << 4}{\cancel{m * 16}}$ ②, ④

8: $b = z + b$ ④

9 = $r = \overset{t4}{\cancel{\text{[illegible]}}}$ ③