21BDS 0340

Abhinav Dinesh Srivatsa

Question 1

1. $S \rightarrow S(S)S \mid \varepsilon$

Checking input ()()

RMD =)

```
            S
            |
        S ( S ) S
        |   |   |
        ε   ε   S ( S ) S
                |   |   |
                ε   ε   ε
```

LMD =)

```
            S
            |
        S ( S ) S
        |   |   |
    S ( S ) S  ε   ε
    |   |   |
    ε   ε   ε
```

2 parse tree

∴ The grammar is ambiguous

2. $S' \rightarrow S$

$S \rightarrow Aa \mid LAc \mid dc \mid Lda$

$A \rightarrow d$

LR(0) items

I_0:

$S' \rightarrow .S$

$S \rightarrow .Aa \mid .LAc \mid .dc \mid .Lda$

$A \rightarrow .d$

	$I_3 \xrightarrow{d} I_6$
$I_0 \xrightarrow{S} I_1$	$S \rightarrow Ld.c$
$S' \rightarrow S.$	$A \rightarrow d.$
$I_0 \xrightarrow{A} I_2$	The state has 1 completed state and
$S \rightarrow A.a$	one requiring a shift. This
	will cause an S-R conflict as
$I_0 \xrightarrow{L} I_3$	Follow(A) = a, c
$S \rightarrow L.Ac \mid L.dc$	
$A \rightarrow .d$	
$I_0 \xrightarrow{d} I_4$	
$S \rightarrow d.c\$$	
$A \rightarrow d.$	
$I_2 \xrightarrow{a} I_5$	
$S \rightarrow Aa.$	

Question 2

1. $S \rightarrow Aa Al \mid BlBa$

Removing useless NT:

$S \rightarrow A \; al \mid ba$

$FIRST(s) = \{a, b\}$

$S, a \rightarrow al$
$S, l \rightarrow ba$

∴ Grammar is $LL(1)$

$l_0: S' \rightarrow .S, \$$	$l_0 \xrightarrow{l} l_3$
$S \rightarrow .al, \$$	$S \rightarrow l.a, \$$
$s \rightarrow .la, \$$	
	$l_3 \xrightarrow{a} l_4$
$l_0 \xrightarrow{a} l_1$	$S \rightarrow la., \$$
$S \rightarrow a.l, \$$	
$l_1 \xrightarrow{l} l_2$	
$S \rightarrow al., \$$	

Each transition is either shift reduce with no overlap

∴ Grammar is $LR(1)$
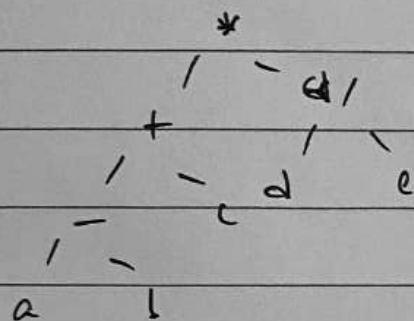
2. $S \to al|La$

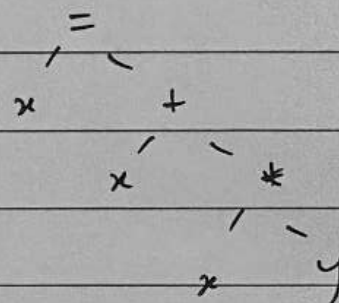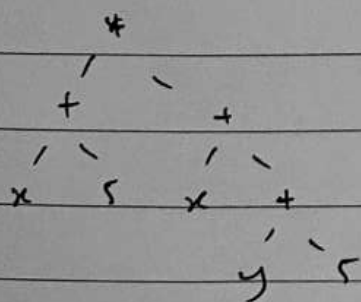Same as the above part

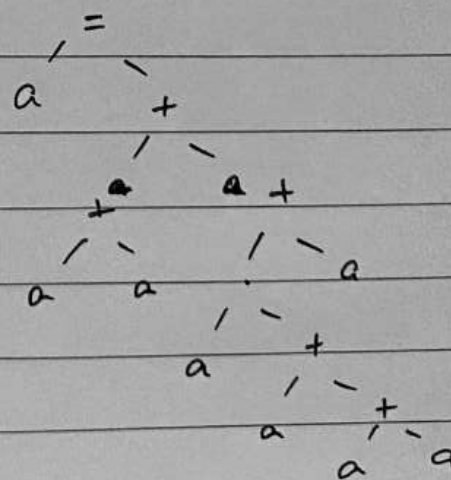Question 3

1.

a. $(a-b) + c * (d/e)$

b. $x = x \perp x * y$

c. $(x+s) * (x+y+s)$

d. $a = (a+a) + a \cdot (a+a+a) + a$

2.
$S \rightarrow (A) \mid 0$

$A \rightarrow SB$

$B \rightarrow , SB \mid \varepsilon$

	0	,	(	)
S	$S \rightarrow 0$		$S \rightarrow (A)$	
A	$A \rightarrow SB$	$\varepsilon c \varepsilon SB$	$A \rightarrow SB$	
B		$B \rightarrow , SB$		$B \rightarrow \varepsilon$

Stack	Input	Action
\$ S	(0,(0,0))	$S \rightarrow (A)$
\$) A (	(0,(0,0))	Match (
\$) A	0,(0,0))	$A \rightarrow SB$
\$) B S	0,(0,0))	$S \rightarrow 0$
\$) B 0	0,(0,0))	Match 0
\$) B	,(0,0))	$B \rightarrow , SB$
\$) B S ,	,(0,0))	Match ,
\$) B S	(0,0))	$S \rightarrow (A)$
\$) B) A (	(0,0))	Match (
\$) B) A	0,0))	$A \rightarrow SB$
\$) B) B S	0,0))	$S \rightarrow 0$
\$) B) B 0	0,0))	Match 0
\$) B) B	,0))	$B \rightarrow , SB$
\$) B) B S ,	,0))	Match ,
\$) B) B S	0))	$S \rightarrow 0$
\$) B) B 0	0))	Match 0
\$) B) B	))	Both $B \rightarrow \varepsilon$
\$	\$	Match \$

Question 4

1.

a. Eliminating common expression

Ex: $a = 10$

   $b = a + 1 + 2$ $a = 10$

   $c = a + 1 * 2$ $\rightarrow$ $b = a + 1 * 2$

   $d = c + a$ $d = b + a$

b. Using computed values again

Ex: $a = 30$

   $b = 20 - a/2$

   $c = b * (30/a + 2) - a$

       $\downarrow$

   $a = 30$

   $b = 20 - 30/2$

   $c = b * (30/30 + 2) - 30$

c. Removing unexecutable code

Ex: $a = 5$ $a = 5$

   return $\rightarrow$ return

   $a = 6$

d. Optimizing loops

Ex: while $(i < 10)$: $s = 3 * i + 1$

    $j = 3 * i + 1$ $\rightarrow$ while $(i < 10)$

                              $j = s$

2. $E \rightarrow E+T$

$T \rightarrow id \mid id \; () \mid id \; (x)$

$x \rightarrow E, E \mid x$

$\Rightarrow$ $E \rightarrow E'$

$E' \rightarrow +TE'$

$T \rightarrow id \; T'$

$T' \rightarrow \varepsilon \mid () \mid (x)$

$x \rightarrow E, E \mid x$

FIRST	FOLLOW
$E = +$	$E = \$$
$E' = +$	$E' = \$$
$T = id$	$T = +$
$T' = (, \varepsilon$	$T' = +$
$x = +$	$x =)$

Question 5

$S \rightarrow S \; op \; S \mid x$	$I_0 \xrightarrow{x} I_2$	$I_3 \xrightarrow{S} I_4$
	$S \rightarrow x \cdot$	$S \rightarrow S \; op \; S \cdot$
$I_0:$		$S \rightarrow S \cdot op \; S$
$S' \rightarrow \cdot S$	$I_1 \xrightarrow{op} I_3$	
$S \rightarrow \cdot S \; op \; S \mid \cdot x$	$S \rightarrow S \; op \cdot S$	$I_3 \xrightarrow{x} I_5 \; I_2$
	$S \rightarrow \cdot S \; op \; S$	$S \rightarrow x \cdot$
$I_0 \xrightarrow{S} I_1$	$S \rightarrow \cdot x$	
$S' \rightarrow S \cdot$		$I_4 \xrightarrow{op} I_5 \; I_3$
$S \rightarrow S \cdot op \; S$		$S \rightarrow S \; op \cdot S$
		$S \rightarrow \cdot S \; op \; S \mid \cdot x$

DFA:

2. b. complicated

Resource intensive

Implementation is not easy

3. (a|L)* a (a|L) (a|L)