

## Cos3701 Task

1.  $(b + a)^*a(b + a)^*a(a + b)^*$

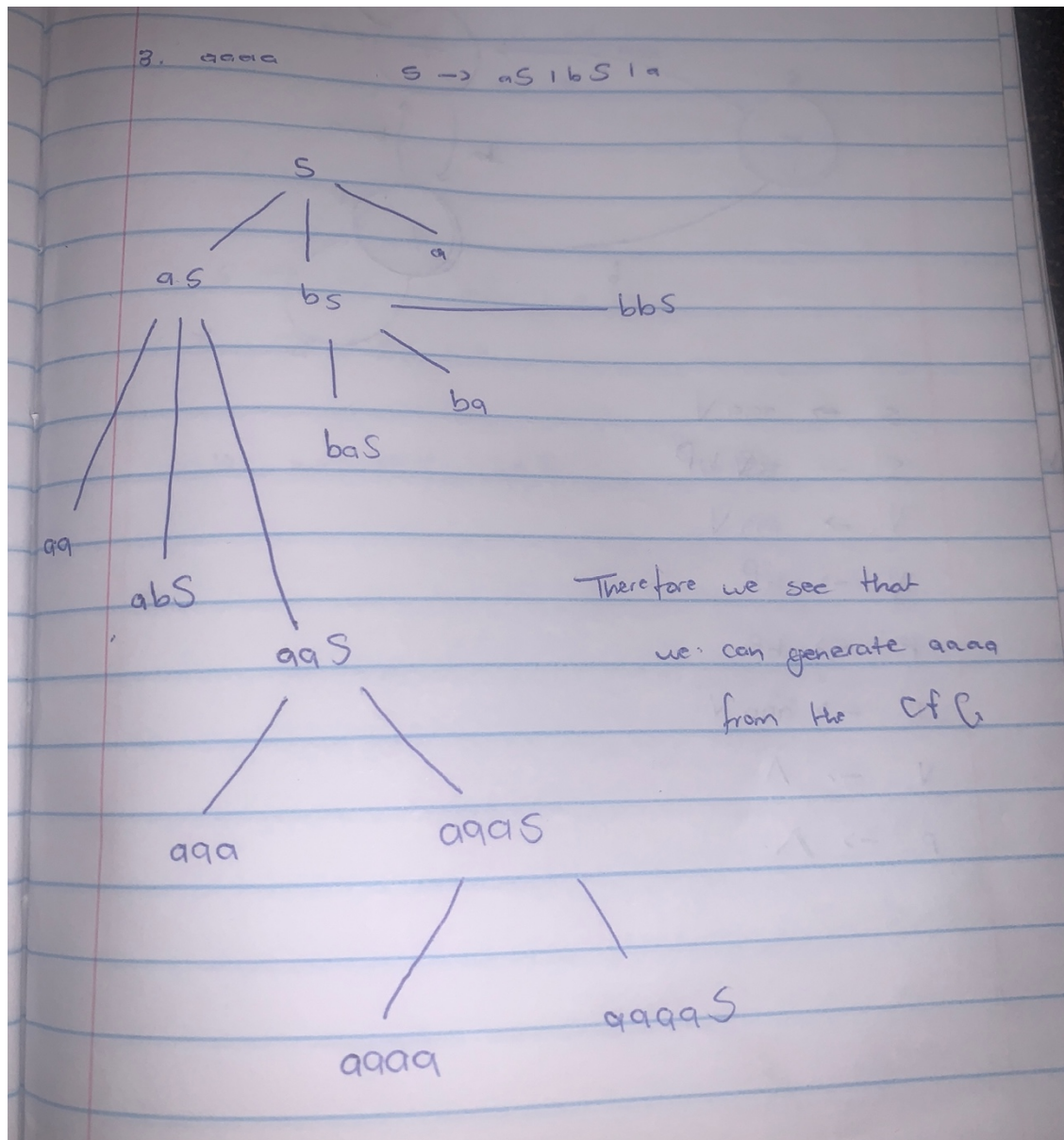
This is the language with atleast 2 a's

2.  $S \rightarrow X \mid Y$

$X \rightarrow aX \mid ab \mid abX$

$Y \rightarrow bY \mid ba \mid baY$

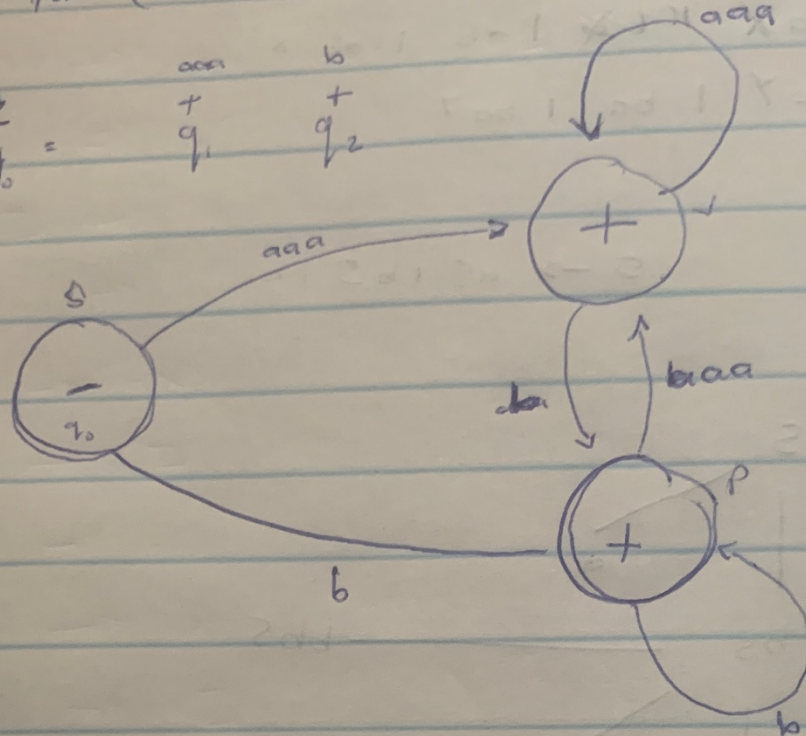
3. ok



4. ok

4. for  $(aaa + b)^*$

$\frac{+}{q_0} = \begin{matrix} aaaa & b \\ + & + \\ q_1 & q_2 \end{matrix}$



$S \rightarrow aaa V$

$S \rightarrow \cancel{ba} bP$

$N \rightarrow aaa V$

$V \rightarrow bP$

$P \rightarrow bP$

$P \rightarrow baa V$

$V \rightarrow \Lambda$

$P \rightarrow \Lambda$

5.  $S \rightarrow aX \mid bS \mid a \mid b$

$X \rightarrow aX \mid a \mid \Lambda$

Since only  $S \rightarrow aX$  and  $X \rightarrow aX$  contain the  $X$  that leads to  $\Lambda$   
**then only  $X \rightarrow a$**

**therefore**

$S \rightarrow aX \mid bS \mid a \mid b$

$X \rightarrow aX \mid a \mid$

Defines the same CFG

6.  $S \rightarrow aXY \mid Z$

$X \rightarrow bbb \mid bX \mid aZ$

$Y \rightarrow aS \mid \Lambda$

$Z \rightarrow a \mid b \mid baY \mid \Lambda$

Split

$S \rightarrow aXY$

$S \rightarrow Z$

$X \rightarrow bbb$

$X \rightarrow bX$

$X \rightarrow aZ$

$Y \rightarrow aS$

$Y \rightarrow \Lambda$

$Z \rightarrow a$

$Z \rightarrow b$

$Z \rightarrow baY$

$Z \rightarrow \Lambda$

Remove the  $\Lambda$

$S \rightarrow aXY$

$S \rightarrow Z$

$X \rightarrow bbb$

$X \rightarrow bX$

$X \rightarrow aZ$

$Y \rightarrow aS$

$Y \rightarrow \mathbf{aX}$

$Y \rightarrow ba$

$Z \rightarrow a$

$Z \rightarrow b$

$Z \rightarrow baY$

Reformulated

$S \rightarrow ZXY$

$S \rightarrow Z$

$X \rightarrow ZZZ$

$X \rightarrow ZX$

$X \rightarrow ZZ$

$Y \rightarrow ZS$

$Y \rightarrow ZX$

$Y \rightarrow ZZ$

$Z \rightarrow ZZY$

$Z \rightarrow a$

$Z \rightarrow b$

Chomsky Normal Form

$S \rightarrow ZR$

$R \rightarrow XY$

$X \rightarrow ZR$

$R \rightarrow ZZ$

$X \rightarrow ZX$

$X \rightarrow ZZ$

$Y \rightarrow ZS$

$Y \rightarrow ZZ$

$Y \rightarrow ZX$

$Z \rightarrow ZR$

$R \rightarrow ZY$

$Z \rightarrow a$

$Z \rightarrow b$



- 
- Handwritten parse tree for the string "abababab" showing a left-recursive derivation:
- Root node  $S$ 
    - Left child:  $bS$  (Annotated: "goes on forever in loop")
      - Left child:  $bbs$ 
        - Left child:  $bbbs$
        - Right child:  $bbS$
      - Right child:  $bs$  (Annotated: "but with a constraint")
        - Left child:  $bax$
        - Right child:  $abs$ 
          - Left child:  $aay$  (Annotated: "which can loop forever")
            - Left child:  $aabY$ 
              - Left child:  $aabY$
              - Right child:  $aabX$
            - Right child:  $aag$
    - Right child:  $ax$ 
      - Left child:  $aay$ 
        - Left child:  $aabY$ 
          - Left child:  $aabY$
          - Right child:  $aabX$
        - Right child:  $aag$
- The string "abababab" is derived from the leaves:  $bax$  (b, a, x) and  $aag$  (a, a, g).

The language of the first 2 b's having an a after them. It also has at least 2 a's.

8.

