

Name: Abdullah Awan

Section: 6A

Roll no: 21L-7713

TOA

ASSIGNMENT #2

Q:1)

Generate (Context Free Grammar) CFG for the following:

a) $(ab+ba)^* \cdot ba$

Language = $\{ \epsilon, bba, abba, babba, abbaabba, baabbbba, ababbbba, \dots \}$

CFG:

$S \rightarrow Abba$

$A \rightarrow abA \mid baA \mid \epsilon$

b) $L = \{a^n b^m c^m d^n; n, m \geq 2\}$

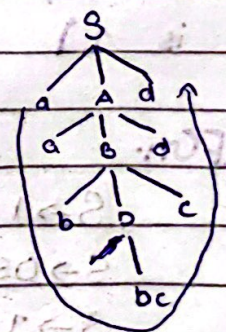
CFG:

$S \rightarrow asd \mid aAd$

$A \rightarrow aAd \mid aBd$

$B \rightarrow bBc \mid bDc$

$D \rightarrow bDc \mid bcb$



aabbccdd

3c) A language with words that have equal no. of a's and b's (in no particular order)

$$L = \{ ab, ba, abba, baab, abab, baba, bbaa, aabb, \dots \}$$

CFG:

$$S \rightarrow aSb \mid bSa \mid \epsilon$$

d) $a^i b^j c^k \mid i, j, k \geq 0$ and $i=j$ or $i=k$

$i=j$ (k can be any value)

$i=k$ (j can be any value)

CFG:

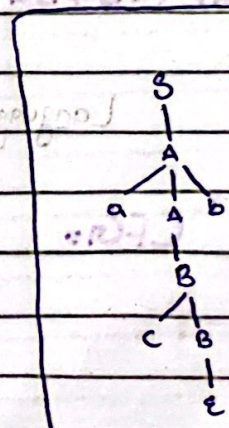
$$S \rightarrow AIC$$

$$A \rightarrow aAb \mid B$$

$$B \rightarrow cB \mid \epsilon$$

$$C \rightarrow aCc \mid A \mid \epsilon$$

$$D \rightarrow bD \mid \epsilon$$



e) $\{x \in \{0,1\}^* \mid \text{the length of } w \text{ is odd and middle symbol is } 1\}$

CFG:

$$S \rightarrow 1 \text{ (This ensures the middle symbol is 1)}$$

$$S \rightarrow 0S0 \text{ (ensure its length is odd by adding '0' on both side)}$$

$$S \rightarrow 1S1 \text{ (ensure its length is odd by adding '1' on both side)}$$

and all combination

So,

$$S \rightarrow 1 \mid 0S0 \mid 1S1 \mid 0S1 \mid 1S0$$

2) $\{i^a j^b k^c \mid a, b, c \geq 0 \text{ and } a+b=c\}$

$S \rightarrow iSK$ (add one 'i' and one 'k' simultaneously)

$S \rightarrow jAK$ (add one 'j' and one 'k' simultaneously)

$S \rightarrow \epsilon$ (if $a+b=c=0$)

So CFG:

~~$S \rightarrow iSK \mid jSK \mid \epsilon$~~

$S \rightarrow iSK \mid A \mid \epsilon$

$A \rightarrow jAK \mid \epsilon$

g) $\{x \in \{0,1\}^* \mid \text{symbol at position } i+2 \text{ and } i+1 \geq 2\}$

CFG:

$S \rightarrow AIBICID$

$A \rightarrow 00A100$

$B \rightarrow 11B111$

$C \rightarrow 10C110$

$D \rightarrow 01D101$

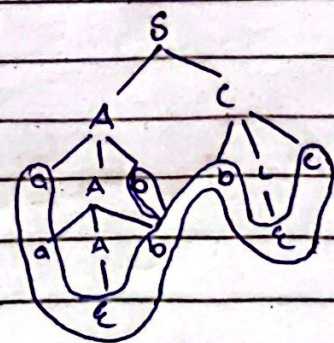
h) $L = \{a^i b^j c^k \mid j=i+k; i \geq 0; k \geq 0\}$

CFG:

$S \rightarrow AC \mid \epsilon$

$A \rightarrow aAb \mid \epsilon$

$C \rightarrow bCc \mid \epsilon$



aabbbc

i) $L = \{a^i b^j c^k; i \leq j; i \geq 0; k \geq 0\}$

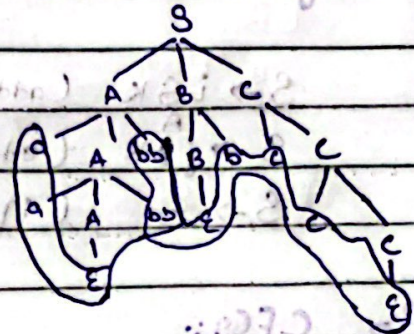
CFG:

$S \rightarrow ABC \mid \epsilon$

$A \rightarrow aAb \mid \epsilon$

$B \rightarrow Bb \mid \epsilon$

$C \rightarrow cC \mid \epsilon$



aabbabbccc

j) $L = \{a^i b^j c^k; i \geq j; i \geq 0; k \geq 0\}$

CFG:

$S \rightarrow AB \mid \epsilon$

$B \rightarrow cB \mid \epsilon$

$A \rightarrow aAXAb \mid \epsilon$

$X \rightarrow aX \mid \epsilon$

