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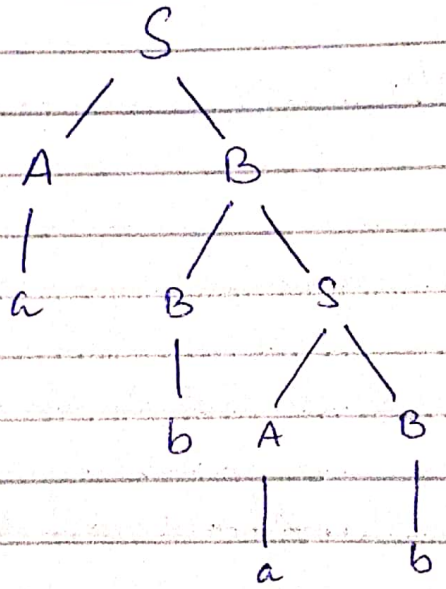
P18-0030
Section B

Question 1.

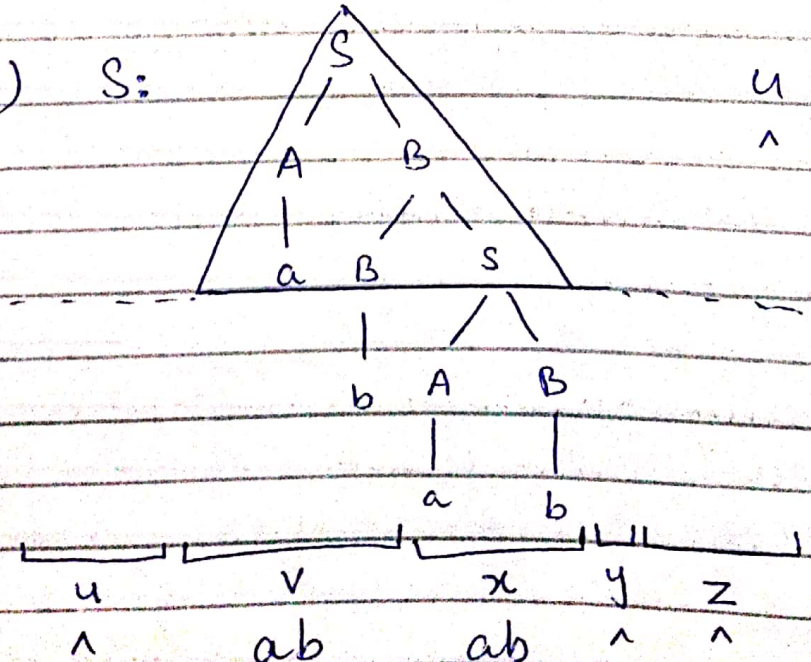
$S \rightarrow AB$
$B \rightarrow BS \mid b$
$A \rightarrow a$

(A) Parse Tree:



(B) No, A is not self-embedded.

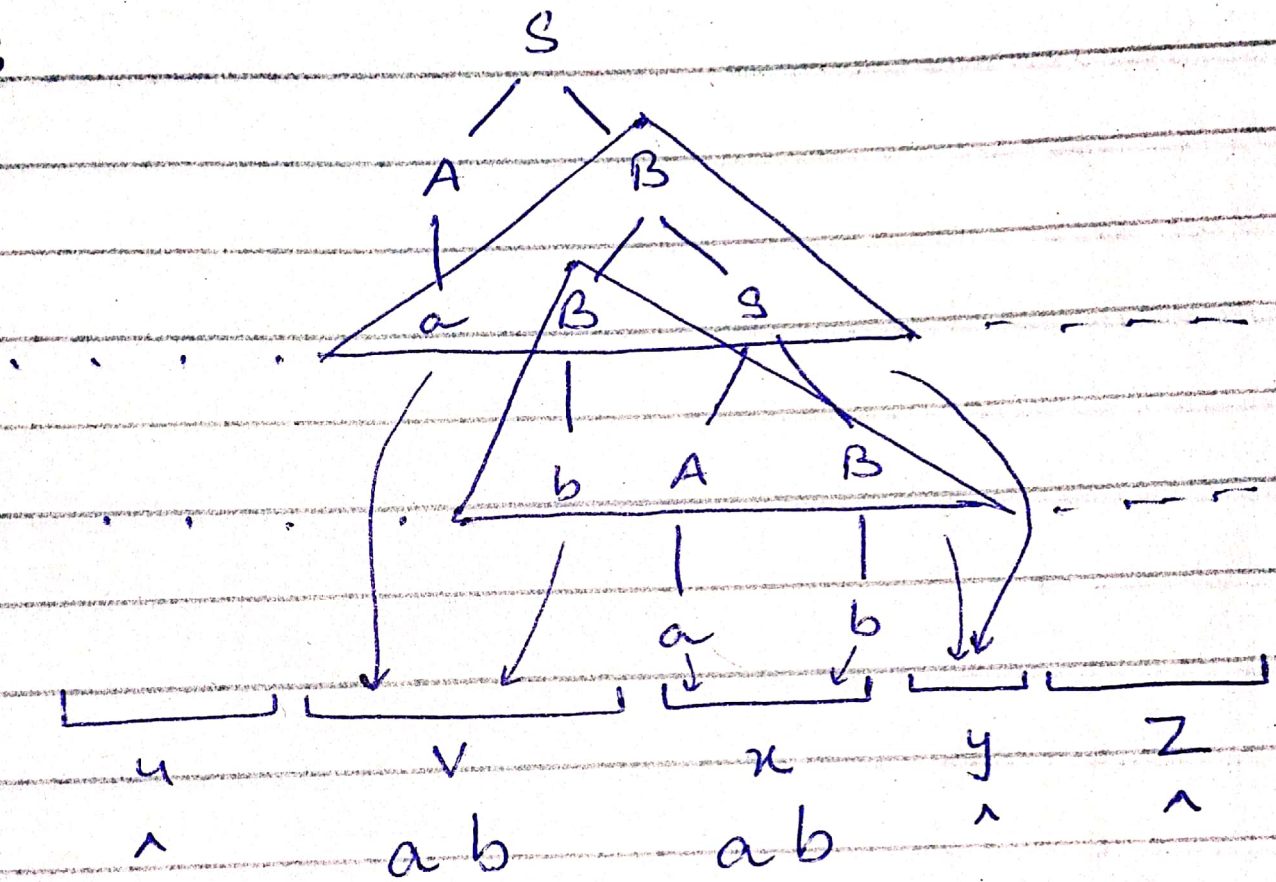
(C) S:



u v x y z
^ abab ^ ^

u	v	x	y	z
^	ab	ab	^	^

B:



u v x y z

^ ab ab ^ ^

Question 2 :

CFG → CNF

$S \rightarrow BSB \mid B \mid \wedge$

$B \rightarrow 00 \mid \wedge$

① Add new start variable

$S_0 \rightarrow S$

$S \rightarrow BSB \mid B \mid \wedge$

$B \rightarrow 00 \mid \wedge$

② Remove $\wedge$ - productions

$S_0 \rightarrow S$

$S \rightarrow BSB \mid B \mid BB$

$B \rightarrow 00 \mid \wedge$

↓

$S_0 \rightarrow S$

$S \rightarrow BSB \mid B \mid BB \mid SB \mid BS \mid S$

$B \rightarrow 00$

③ Remove unary productions

$S_0 \rightarrow S$

$S \rightarrow BSB \mid B \mid BB \mid SB \mid BS \mid \wedge$

$B \rightarrow 00$

↓

$S_0 \rightarrow BSB \mid B \mid BS \mid SB \mid BB$

$S \rightarrow BSB \mid B \mid BS \mid SB \mid BB$

$B \rightarrow 00$

↓

$S_0 \rightarrow BSB \mid 00 \mid BS \mid SB \mid BB$

$S \rightarrow BSB \mid 00 \mid BS \mid SB \mid BB$

$B \rightarrow 00$

↓

$S_0 \rightarrow BSB \mid CC \mid BS \mid SB \mid BB$

$S \rightarrow BSB \mid CC \mid BS \mid SB \mid BB$

$B \rightarrow CC$

$C \rightarrow 0$

↓

$S_0 \rightarrow DB \mid CC \mid BS \mid SB \mid BB$

$S \rightarrow DB \mid CC \mid BS \mid SB \mid BB$

$B \rightarrow CC$

$C \rightarrow 0$

$D \rightarrow BS$

Question 3.

(a) $L1 = \{a^n b^m a^m \mid n, m \geq 0\}$

$n = 3$

$m = 4$

aaabbbbaaaa

$\underbrace{aa}_{u}\underbrace{ab}_{v}\underbrace{bb}_{x}\underbrace{ba}_{y}\underbrace{aaa}_{z}$

Pumping Lemma on $uv^n xy^n z$

$n = 2$ aaabab bb baba aaa

this word is not accepted by L1

so this is non-CFL.

(b) $L2 = \{a^n b^n a^m \mid n, m \geq 0\}$

$n = 3$ aaabbb aaaaa

$m = 5$

aa a b b b a a a a a

u v x y z

Pumping lemma

$n = 2$ aa abbabbb a aaaa aa

$n = 3$ aaabbabbabbb baaaaaaaaa

These words are not accepted by L2 so this is non-CFL.

(c) $L3 = \{a^i b^j c^k \mid i = j = k\}$

$i = j = k = 3$ aaabbbccc

a a a b b b c c c

u v x y z

$n = 2$ aa abab bb cc cc

$n = 3$ aa ababab bb ccccc

These words are not accepted by L3

so this is non-CFL.