4.1

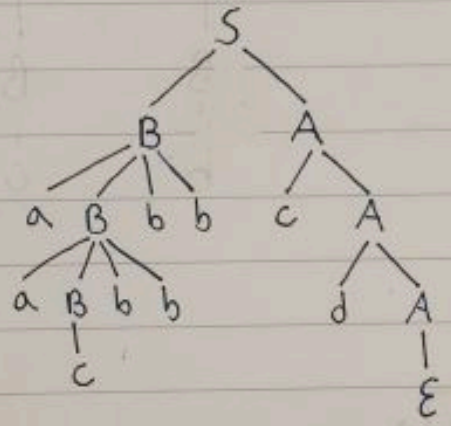
$S \to BA$
$A \to cA \mid dA \mid \varepsilon$
$B \to aBbb \mid c$

a) $S \to BA \xrightarrow{B \to c} cA \xrightarrow{A \to dA} cdA \xrightarrow{A \to cA} cdcA \xrightarrow{A \to \varepsilon} cdc$

$S \to BA \xrightarrow{A \to \varepsilon} B \xrightarrow{B \to aBbb} aBbb \xrightarrow{B \to c} acbb$

$S \to accba$ - not possible

b)



c) $S \xrightarrow{S \to BA} BA \xrightarrow{A \to cA} BcA \xrightarrow{A \to dA} BcdA \xrightarrow{A \to \varepsilon} Bcd \xrightarrow{B \to aBbb} aBbbcd$
$\xrightarrow{B \to aBbb} aaBbbbbcd \xrightarrow{B \to c} aacbbbbcd$

d) $L = \{a^n c b^{2n} (cld)^k \mid n \geq 0 ; k \geq 0\}$

4.4

a) $S \to dA$
$A \to ccAa \mid b$

$\cup$

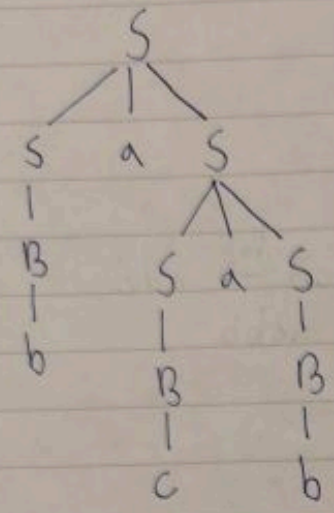
$S \to aAb$
$A \to cA \mid c$

b) expression → variable
| !expression
| expression || expression
| expression && expression
| (expression)

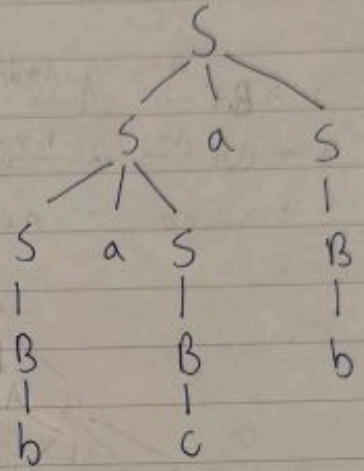
variable → x | y | z

4.6

a)



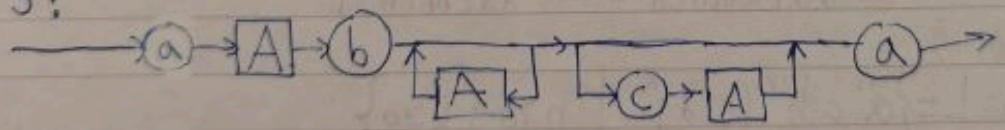
b) G is ambiguous because there are 2 different trees for same string



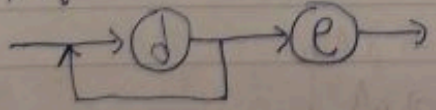
4.9

a) $S \rightarrow aAbA^*[cA]a$
$A \rightarrow d^+e$

S:



A:



b) $S \rightarrow aAbXYa$
$A \rightarrow Ze$
$Z \rightarrow dZ \mid d$
$X \rightarrow AX \mid \varepsilon$
$Y \rightarrow cA \mid \varepsilon$