1) $G = (\{S\}, \{a, b\}, S, P)$

with production rules

$S \to aS \,/\, bS \,/\, a$

$S \to a$

$S \to aS \to aa$

$S \to aS \to abS \to aba$

$S \to bS \to ba$

$S \to bS \to bbS \to bba$

$(a^m b^n a^p \,/\, m, n \geq 0, P \geq 1)$

11) $G = (\{S, A, B\}, \{a, b\}, S, P)$

with production rules

$S \to aAb \,/\, aBb \,/\, aSb$

$A \to aA \,/\, a$

$B \to bB \,/\, b$

$S \to aAb \to aab$

$S \to aBb \to abb$

$S \to aBb \to abBb \to abbb$

$S \to aSb \to aaBbb \to aabbb$

$S \to aSb \to aaBbb \to aabBbb \to aabbbb$

$(a^n b^m \,/\, m, n \geq 1)$

$B \to b$

$S \to \lambda$

$S \to AS \to aS \to a\lambda \to a$

$S \to AS \to aS \to aAS \to aaS \to aa\lambda \to aaa$

$S \to AS \to aS \to aBS \to abS \to abBS \to abbS \to abb\lambda \to abb$

$S \to BS \to bS \to b\lambda \to b$

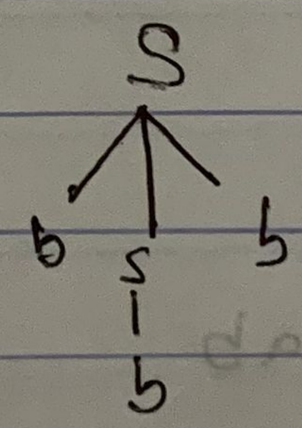
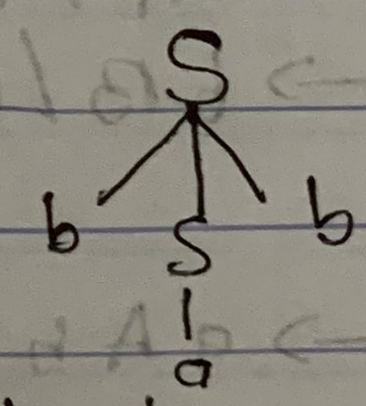
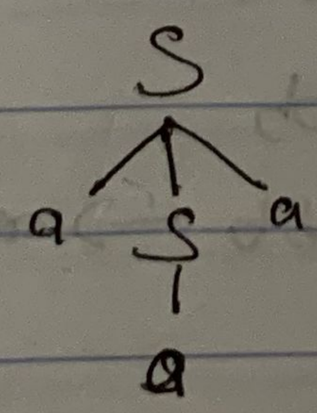
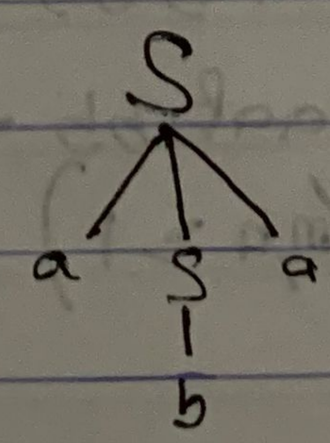
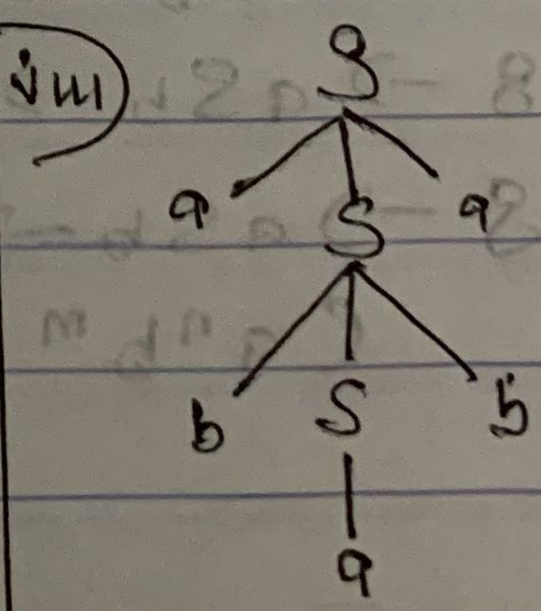
$S \to BS \to bS \to bBS \to bbS \to bb\lambda \to bb$

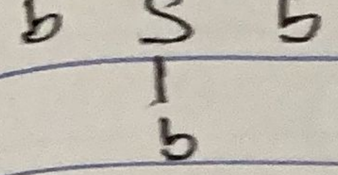
$S \to BS \to bS \to bAS \to baS \to ba\lambda \to ba$

$G(\{S\}, \{a,b\}, S, P)$

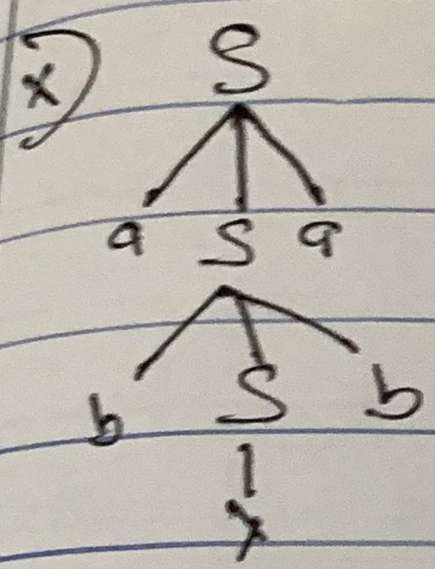
with production rules

$S \to aSa \,/\, bSb \,/\, a \,/\, b \,/\, \lambda$

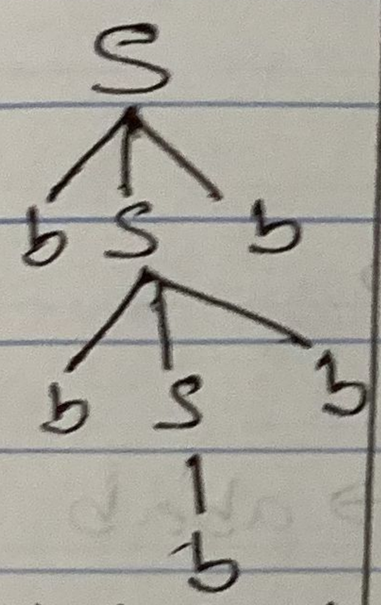
S | λ $\to \lambda$	iii) S | b $\to b$	v)  $\to bbb$	vii)  $\to bab$
S | a $\to a$	iv)  $\to aaa$	vi)  $\to aba$	viii)  $\to ababa$



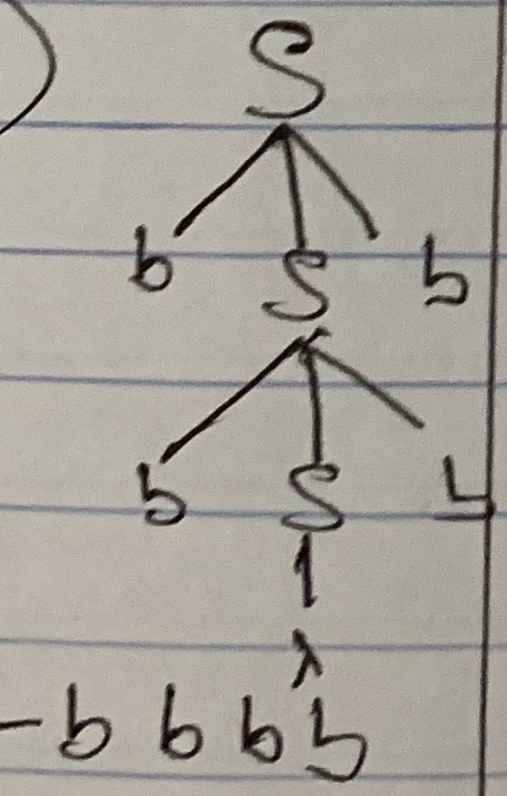
— abbba



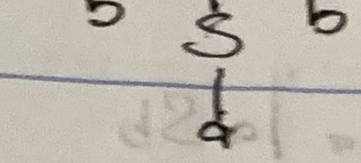
— abbba



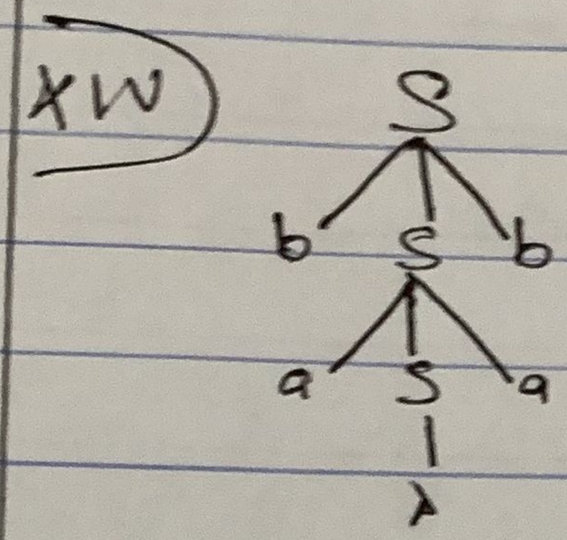
— bbbbb



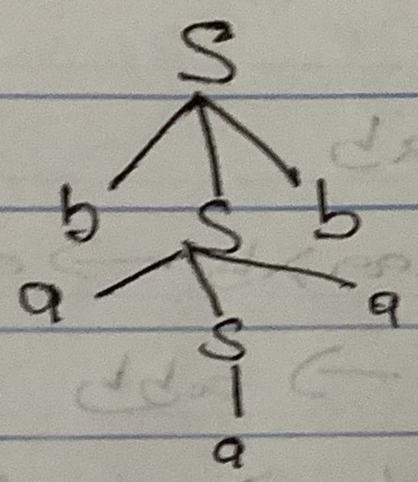
— bbbb



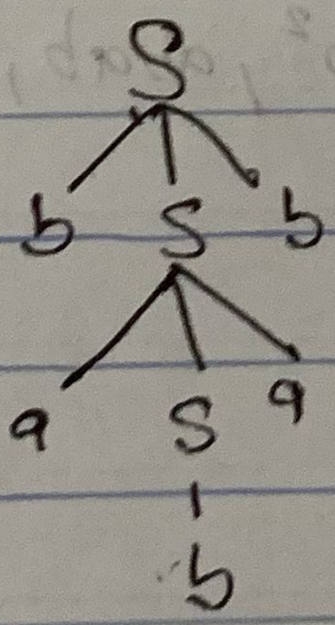
— bbab



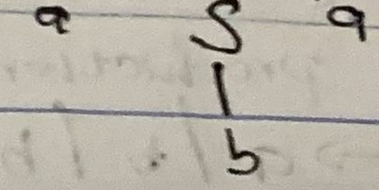
— baab



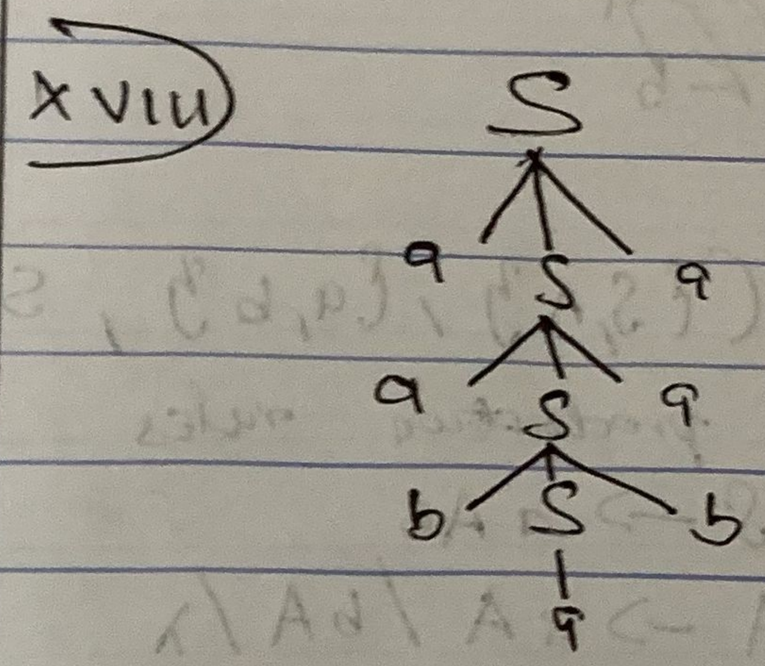
— baaab



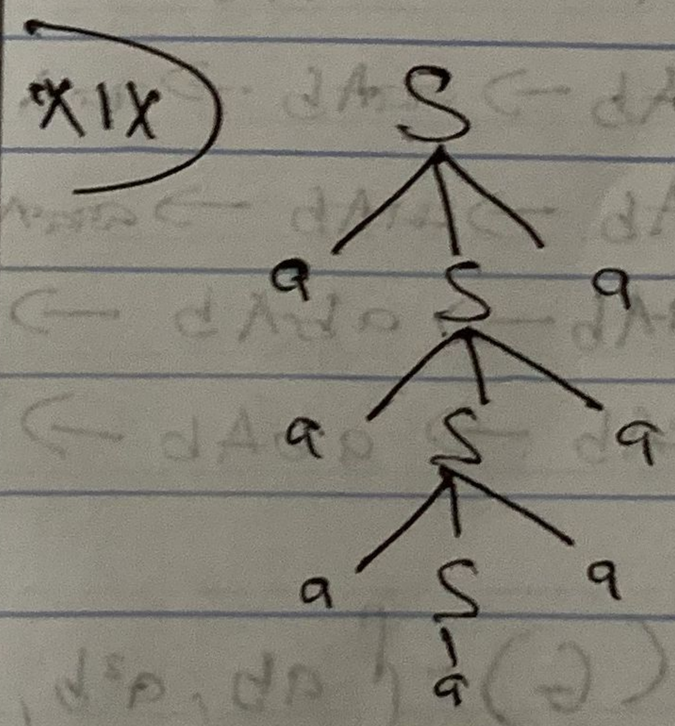
— babab



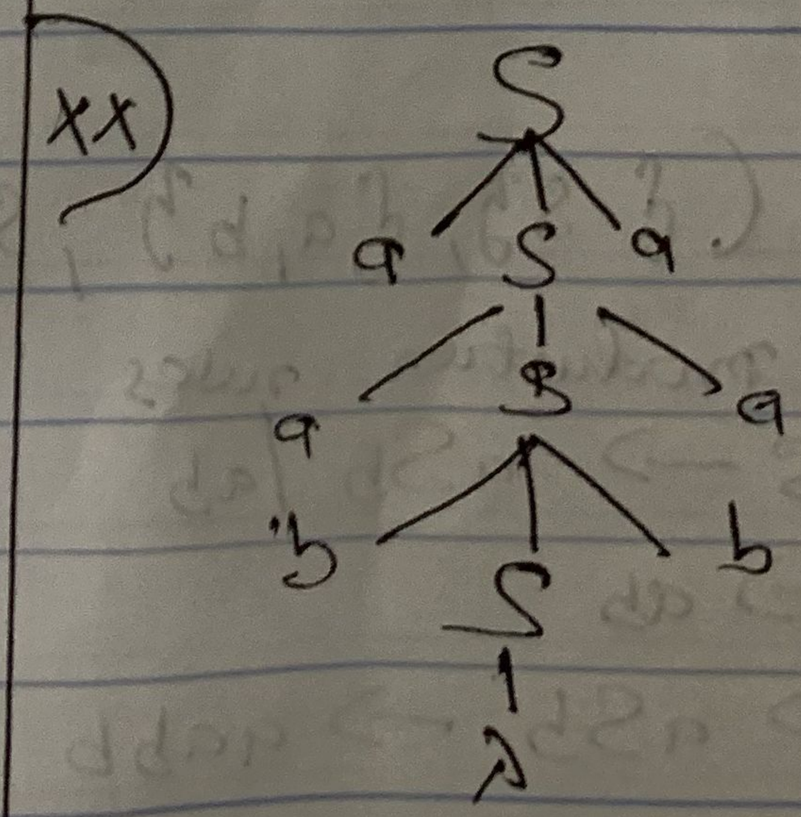
— aabaa



— aababaa



— aaaaaaa



— aabbaa

with production

$S \to a \mid b \mid bSb \mid aSa \mid bSa \mid aSb$

$\cancel{S \to a}$

$\cancel{S \to b}$

$G = (\{S, A\}, \{a, b\}, S, P)$

with production rules

$S \to aAb$

$A \to aA \mid bA \mid \lambda$

$\to aAb \to a\lambda b \to ab$

$\to aAb \to aaAb \to aa\lambda b \to aab$

$\to aAb \to aaAb \to aaaAb \to aaa\lambda b \to aaab$

$\to aAb \to abAb \to ab\lambda b \to abb$

$\to aAb \to abAb \to abaAb \to aba\lambda b \to abab$

$L(G) = \{ab, a^2b, a^3b, ab^2, abab, \ldots\}$

$G = (\{S\}, \{a, b\}, S, P)$

with production rules

$S \to aSb \mid ab$

$S \to ab$

$S \to aSb \to aabb$

$L(G) = \{ab, a^2b^2, a^3b^3\} = \{a^m b^m \mid m \geq 1\}$

$A \to aAb \mid ab$

$\to aABc \to aabc$

$\to aSc \to aaAcc \to aaabcc$

$S \to aAc \to aaAbc \to aaabbc$

$S \to aSc \to aaScc \to aaaAcc \to aaaaAbcc \to aaaaabbcc$

$L(G) = \{a^2bc, a^3bc^2, a^2b^2c, a^5b^2c^2, \ldots\}$
$= \{a^n b^m c^p \mid n, m, p \geq 1\}$

) $G = (\{S, A, B\}, \{a, b\}, S, P)$

with production rules

$S \to AB$

$B \to bB \mid b$

$A \to aA \mid a$

$S \to AB \to aB \to ab$

$S \to AB \to aAB \to aAbB \to aabB \to aabb$

$L(G) = \{ab, a^2b^2, a^3b^3, \ldots\}$
$= \{a^n b^n \mid n > 0\}$