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17/SC101/036

CSC 804

Answers

1i)  $S \rightarrow as/bS/g$

$S \xrightarrow{*} a$

$S \rightarrow as \rightarrow aa$

$S \xrightarrow{*} aa$

$S \rightarrow bs \rightarrow br$

$S \xrightarrow{*} ba$

$S \rightarrow as \rightarrow aas \rightarrow aqa$

$S \xrightarrow{*} aqa$

$S \rightarrow as \rightarrow abs \rightarrow aba$

$S \xrightarrow{*} aba$

$S \rightarrow bs \rightarrow bas \rightarrow baqa$

$S \xrightarrow{*} baqa$

$S \rightarrow bs \rightarrow bbs \rightarrow bba$

$S \xrightarrow{*} bba$

$L(E) = \{a, aa, ba, aqa, aba, baqa, bba, \dots\}$

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

$$1ii) S \rightarrow AS / BS / \lambda$$

$$A \rightarrow a$$

$$B \rightarrow b$$

$$S \xrightarrow{*} \lambda$$

$$S \rightarrow AS \rightarrow A\lambda \rightarrow A \xrightarrow{*} a$$

$$S \rightarrow BS \rightarrow B\lambda \rightarrow B \xrightarrow{*} b$$

$$S \rightarrow AS \rightarrow AAS \rightarrow AA\lambda \rightarrow AA \xrightarrow{*} aa$$

$$S \rightarrow AS \rightarrow ABS \rightarrow AB\lambda \rightarrow AB \xrightarrow{*} ab$$

$$S \rightarrow BS \rightarrow BAS \rightarrow BA\lambda \rightarrow BA \xrightarrow{*} ba$$

$$S \rightarrow BS \rightarrow BBS \rightarrow BB\lambda \rightarrow BB \xrightarrow{*} bb$$

$$S \rightarrow AS \rightarrow AAS \rightarrow AAAS \rightarrow AAA\lambda \rightarrow AAA \xrightarrow{*} aaa$$

$$S \rightarrow AS \rightarrow AAS \rightarrow AABS \rightarrow AAB\lambda \rightarrow AAB \xrightarrow{*} aab$$

$$S \rightarrow AS \rightarrow ABS \rightarrow ABAS \rightarrow AB\lambda \rightarrow ABA \xrightarrow{*} aba$$

$$S \rightarrow AS \rightarrow ABS \rightarrow ABBS \rightarrow ABB\lambda \rightarrow ABB \xrightarrow{*} abb$$

$$S \rightarrow BS \rightarrow BAS \rightarrow BAAS \rightarrow BAA\lambda \rightarrow BAA \xrightarrow{*} baa$$

$$S \rightarrow BS \rightarrow BAS \rightarrow BABS \rightarrow BAB\lambda \rightarrow BAB \xrightarrow{*} bab$$

$$S \rightarrow BS \rightarrow BBS \rightarrow BBBBS \rightarrow BBB\lambda \rightarrow BBB \xrightarrow{*} bbb$$

$$L(G) = \{ \lambda, a, b, aa, ab, ba, bb, aaa, aab, aba, abb, baa, \dots \}$$

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

$$\text{iii) } S \rightarrow aAb / aBb / aSb$$

$$A \rightarrow aA / a$$

$$B \rightarrow bB / b$$

$$S \rightarrow aAb \rightarrow aab$$

$$S \xrightarrow{*} aab$$

$$S \rightarrow aBb \rightarrow abb$$

$$S \xrightarrow{*} abb$$

$$S \rightarrow aAb \rightarrow aaAb \rightarrow aaab$$

$$S \xrightarrow{*} aaab$$

$$S \rightarrow aBb \rightarrow abBb \rightarrow abbb$$

$$S \xrightarrow{*} abbb$$

$$S \rightarrow aSb \rightarrow aaAbb \rightarrow aaabb$$

$$S \xrightarrow{*} aaabb$$

$$S \rightarrow aSb \rightarrow aaBbb \rightarrow aabbb$$

$$S \xrightarrow{*} aabbb$$

$$L(G) = \{ aab, abb, aaab, abbb, aaabb, aabbb, \dots \}$$

$$L(G) = \{ aa^n b^m b \mid n, m \geq 0 \text{ and } n \neq m \}$$

$$2) S \rightarrow aSa / bSb / a / b / \lambda$$

$$1 - S \xrightarrow{*} \lambda$$

$$2 - S \xrightarrow{*} a$$

$$3 - S \xrightarrow{*} b$$

$$4 - S \rightarrow aSa \rightarrow a\lambda a \xrightarrow{*} aa$$

$$5 - S \rightarrow bSb \rightarrow b\lambda b \xrightarrow{*} bb$$

$$6 - S \rightarrow aSa \xrightarrow{*} aqa$$

$$7 - S \rightarrow aSa \xrightarrow{*} aba$$

$$8 - S \rightarrow bSb \xrightarrow{*} bab$$

$$9 - S \rightarrow bSb \xrightarrow{*} bbb$$

$$10 - S \rightarrow aSa \rightarrow qaSa \rightarrow aa\lambda aa \xrightarrow{*} aaaa$$

$$11 - S \rightarrow aSa \rightarrow abSba \rightarrow ab\lambda ba \xrightarrow{*} abba$$

$$12 - S \rightarrow bSb \rightarrow baSab \rightarrow ba\lambda ab \xrightarrow{*} baab$$

$$13 - S \rightarrow bSb \rightarrow bbSbb \rightarrow bb\lambda bb \xrightarrow{*} bbbb$$

$$14 - S \rightarrow aSa \rightarrow aaSaa \xrightarrow{*} aaaaa$$

$$15 - S \rightarrow aSa \rightarrow aaSaa \xrightarrow{*} aabaa$$

$$16 - S \rightarrow aSa \rightarrow abSba \xrightarrow{*} ababab$$

$$17 - S \rightarrow aSa \rightarrow abSba \xrightarrow{*} abbba$$

$$18 - S \rightarrow bSb \rightarrow baSab \xrightarrow{*} baaab$$

$$19 - S \rightarrow bSb \rightarrow baSab \xrightarrow{*} babab$$

$$20 - S \rightarrow bSb \rightarrow bbSbb \xrightarrow{*} bbabb$$

$$L(G) = \{ \lambda, a, b, aa, bb, aqa, aba, bab, bbb, aaaa, abba, baab, bbbb, aaaaqa, \dots \}$$

$$L(G) = \{ a^x b^y a^n b^m b^j a^z \mid x, y, n, m, j, z \geq 0 \}$$

3)  $L(G) = \{a, b, aaa, aab, aba, abb, baa, bab, bba, bbb, aaaaa, aaaaab, aaabaa, \dots\}$

$$S \rightarrow aSS / bSS / a / b$$

$$S \xrightarrow{*} a$$

$$S \xrightarrow{*} b$$

$$S \rightarrow aSS \xrightarrow{*} aaa$$

$$S \rightarrow aSS \xrightarrow{*} aab$$

$$S \rightarrow aSS \xrightarrow{*} aba$$

$$S \rightarrow aSS \xrightarrow{*} abb$$

$$S \rightarrow bSS \xrightarrow{*} baa$$

$$S \rightarrow bSS \xrightarrow{*} bab$$

$$S \rightarrow bSS \xrightarrow{*} bba$$

$$S \rightarrow bSS \xrightarrow{*} bbb$$

$$S \rightarrow aSS \rightarrow aaSSS \xrightarrow{*} aaaaaa$$

⋮

$$\text{4i) } S \rightarrow aAb$$

$$A \rightarrow aA / bA / \lambda$$

$$S \rightarrow aAb \rightarrow a\lambda b \xrightarrow{*} ab$$

$$S \rightarrow aAb \rightarrow aaAb \rightarrow aa\lambda b \xrightarrow{*} aab$$

$$S \rightarrow aAb \rightarrow abAb \rightarrow ab\lambda b \xrightarrow{*} abb$$

$$S \rightarrow aAb \rightarrow aaAb \rightarrow aaaAb \rightarrow aaa\lambda b \xrightarrow{*} aaab$$

$$S \rightarrow aAb \rightarrow aaAb \rightarrow aabAb \rightarrow aabb\lambda b \xrightarrow{*} aabb$$

$$L(G) = \{ ab, aab, abb, aaab, aabb, \dots \}$$

~~$$L(G) = \{ a^n (a+b)^m \}$$~~

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

$$\text{4ii) } S \rightarrow aSb / ab$$

$$S \rightarrow aSb \xrightarrow{*} aabb$$

$$S \rightarrow aSb \rightarrow aaSbb \xrightarrow{*} aaabbb$$

$$S \rightarrow aSb \rightarrow aaSbb \rightarrow aaaSbbb \xrightarrow{*} aaaabbbb$$

$$L(G) = \{ aabb, aaabbb, aaaabbbb, \dots \}$$

$$L(G) = \{ (ab)^n \mid n > 1 \}$$

$$\text{Hiii) } S \rightarrow aSc \mid aAc$$

$$A \rightarrow aAb \mid ab$$

$$S \rightarrow aAc \xrightarrow{*} aabc$$

$$S \rightarrow aAc \rightarrow aaAbc \xrightarrow{*} aaabbc$$

$$S \rightarrow aSc \rightarrow aaAcc \xrightarrow{*} aaabcc$$

$$S \rightarrow aSc \rightarrow aaAcc \rightarrow aaaAbcc \xrightarrow{*} aaaabbbc$$

$$L(G) = \{ aabc, aaabbc, aaabcc, aaaabbbc, \dots \}$$

$$L(G) = \{ a^x b^y c^z \mid x, y, z > 0 \}$$

$$\text{Hiv) } S \rightarrow AB$$

$$B \rightarrow bB \mid b$$

$$A \rightarrow aA \mid a$$

$$S \rightarrow AB \xrightarrow{*} ab$$

$$S \rightarrow AB \rightarrow aAB \xrightarrow{*} aab$$

$$S \rightarrow AB \rightarrow AbB \xrightarrow{*} abb$$

$$S \rightarrow AB \rightarrow aAbB \xrightarrow{*} aabb$$

$$S \rightarrow AB \rightarrow aAbB \rightarrow aaAbB \xrightarrow{*} aaabb$$

$$S \rightarrow AB \rightarrow aAbB \rightarrow aAbbB \xrightarrow{*} aabbb$$

$$S \rightarrow AB \rightarrow aAbB \rightarrow aaAbbB \xrightarrow{*} aaabbb$$

$$L(G) = \{ ab, aab, abb, aabb, aaabb, aabbb, aaabbb, \dots \}$$

$$L(G) = \{ aa^n b^m b \mid n, m \geq 0 \}$$