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Given the context – free grammar G is

$R \to XRX \mid S$
$S \to aTb \mid bTa$
$T \to XTX \mid X \mid \varepsilon$
$X \to a \mid b$

a. The variables of G are R, S, T and X

Variables are the non-terminal symbols that appear in the rules of the grammar.

b. The terminals of G are a, b.

Terminals are the terminal symbols that appear in the rules of the grammar.

c. The start variable of G is R.

$R \to XRX \mid S$

Start variable is a variable usually occurs on the left – hand side of the topmost rule.

d. Case1: Consider the rule $R \to S$

Substitute S with rule $S \to aTb$

$R \to aTb$

Substitute T with rule $T \to \varepsilon$.

$R \to a \in b$
$R \to ab$

Case2: Consider the rule $R \to S$

Substitute S with rule $S \to bTa$

$R \to bTa$

Substitute T with rule $T \to \varepsilon$.

$R \to b \in a$
$R \to ba$

Case3: Consider the rule $R \to S$

Substitute S with rule $S \to aTb$

$R \to aTb$

Substitute T with rule $T \to X$.

$R \to aXb$

Substitute X with rule $X \to a$.

$R \to aab$

Therefore, the 3 strings in $L(G)$ are ab, ba and aab.

e. The three strings not in $L(G)$ are aba, b and ε. Since these strings cannot be derived from the given grammar *G*.

f. False

$T \Rightarrow aba$, the string cannot be derived using G.

g. True

$T \overset{*}{\Rightarrow} aba$, the string can be derived using G.

h. False

$T \Rightarrow T$, the string cannot be derived using G.

i. True

$T \overset{*}{\Rightarrow} T$, the string can be derived using G.

j. True

$XXX \overset{*}{\Rightarrow} aba$, the string can be derived using G.

k. False

$X \overset{*}{\Rightarrow} aba$, the string cannot be derived using G.

l. True

$T \overset{*}{\Rightarrow} XX$, the string can be derived using G.

m. True

$T \overset{*}{\Rightarrow} XXX$, the string can be derived using G.

n. False

$S \overset{*}{\Rightarrow} \varepsilon$, the string cannot be derived using G.

o. $L(G)$ consists of all strings that are not palindromes and are formed over terminal symbols a and b.