Theory of Computation Assignment No. 3

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Q1) Find the language generated by the grammar on $\{a, b\}^*$ and provide a proof?
Grammar:

$$S \rightarrow aAb \mid AB$$
$$A \rightarrow aAb \mid B \mid a$$
$$B \rightarrow bBa \mid a$$

Sol: The language(L) generated is the union of set of languages,
L $= \cup_{i=0}^{13} L_i$

$L_1 = \{a^n b^n, n \geq 1\}$ $\qquad$ $L_2 = \{a^{n+1} b^n, n \geq 1\}$
$L_3 = \{a^n b^{n+1}, n \geq 1\}$ $\qquad$ $L_4 = \{a^n b^{n+2}\}$
$L_5 = \{b^{n+2} a^n, n \geq 1\}$ $\qquad$ $L_6 = \{ab^{n+1} a^n, n \geq 1\}$
$L_7 = \{b^{n+1} a^n b^{m+1} a^m; m, n \geq 1\}$ $\quad$ $L_8 = \{a^n b^{m+1} a^m b^m; m, n \geq 1\}$
$L_9 = \{b^{n+1} a^n b, n \geq 1\}$ $\qquad$ $L_{10} = \{a^{n+1} b^{m+n+1} a^m; m, n \geq 1\}$
$L_{11} = \{a^n b^{m+1} a^m b^{n+1}; m, n \geq 1\}$ $\quad$ $L_{12} = \{a^n b^{m+1} a^m b^{n+l+2} a^l; l, m, n \geq 1\}$

L_1 is derived by the following derivations:

$$S \rightarrow AB$$
$$A \rightarrow aAb$$
$$B \rightarrow b$$

only ab can be derived by,

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

L_2 is derived by the following derivations:

$$S \rightarrow aAb$$
$$A \rightarrow aAb \mid a$$

L_3 is derived by the following derivations:

$$S \rightarrow aAb$$
$$A \rightarrow aAb$$

after reaching upto n $a's$ and $b's$ then,
A →B and B →b

L_4 is derived by the following derivations:

$$S →AB$$
$$A →aAb$$

after reaching upto n $a's$ and $b's$ then,
A →B and B →b
and the right-most B →b

L_5 is derived by the following derivations:

$$S →AB$$
$$A →B$$

after reaching upto n $b's$ and $a's$ then,
A →B(B →b) and
right-most B derives,

$$B →bBa$$

and then b.