**Problem 2.** Prove that $CRYPT$ is not regular.

**Proof:**
We assume $CRYPT$ is regular. We choose a word $w$in CRYPT and pump it to get a contradiction.

Pumping Lemma says that $w$can be written as $xyz$, with $|y| >= 1$ such that all $xy^nz$ is also in $CRYPT$.

Suppose ,

$$w = VIGENERE(LOCTRAN(SIMPLESUB(E, STRING), DIGIT), STRING)$$

which can be generated by the given grammar.

Therefore, $xy$ only contains $VIGENERE(LOCTRAN(SIMPLESUB($

We get contradiction on the following cases:

Case 1: $y$ is $SIMPLESUB($

$xyyz$ is not a word in $CRYPT$ since there is no key available for the relevant $SIMPLESUB($ and also does not support the given grammar.

Case 2: $y$ is $VIGENERE($

$xyyz$ is not a word in $CRYPT$ since there is no key available for the relevant $VIGENERE($ and also does not support the given grammar.

Case 3: $y$ is $LOCTRAN($

$xyyz$ is not a word in $CRYPT$ since there is no key available for the relevant $LOCTRAN($ and also does not support the given grammar.

Case 4: $y$ is (

$xyyz$ is not a word in $CRYPT$ since there is no ) for relevant ( .

Therefore by contradiction, we can prove that $CRYPT$ is not regular.