**Part 1**

Language: The language which accepts all valid arithmetic equations derived by symbols in the alphabet

Alphabet: $\sum$ = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, (, ), +, -, x, /}

The rules of the language are the same as regular arithmetic. All left parenthesis must be balanced with one on the right, there must be numbers on either side of an operator (or a grouping that itself can evaluate to a number). An example of something that must not be allowed is 5+(+5) since in this scenario there is nothing that the 5 inside the parenthesis that can be evaluated. You must not be able to divide by 0, as in mathematics this is undefined and would not be able to be calculated properly. It needs to be able to accept numbers of any size, positive or negative. The negatives would be implemented using the same symbol as the minus sign, so there are some instances in this language where two minus symbols back to back would be considered acceptable (for example 5+-5, since it can be read as 5 + (-5)).

The intent of this language is to include all strings that accurately describe basic arithmetic expressions. For the structure of this language, we utilized a Pushdown Automata to be able to accept arithmetic equations that fit into the grammar.

The purpose of this program would be for something like a calculator which needs to be able to determine what user inputs are allowed, since equations have to follow a

specific syntax to be calculable. For that purpose this also could be heavily expanded as higher level math gets further incorporated needing more specific rules and flow starts. We initially considered having all the equations end with an equals sign, but found it unnecessary given that in the scenario you would find something like this used most often, a calculator, you would not input the equals sign itself. It is something that is more so just implied to be at the end of every expression.

**Part 2:**

Formal Grammar:

S -> A+AS | A-AS | AxAS | A/AS | (S) | lambda
A -> 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | AA | (A)