Backus-Naur Form (BNF): First assignment

Abstract
This assignment provided us with the opportunity to create BNF grammar descriptions for a given set of rules and also make parse trees for certain given sentences. This allowed us to understand how various languages work with a given set of syntax. The main objective of this assignment was to familiarize oneself with structuring BNF and to construct sentences based on the grammar. Here are solutions to the given set of problems.

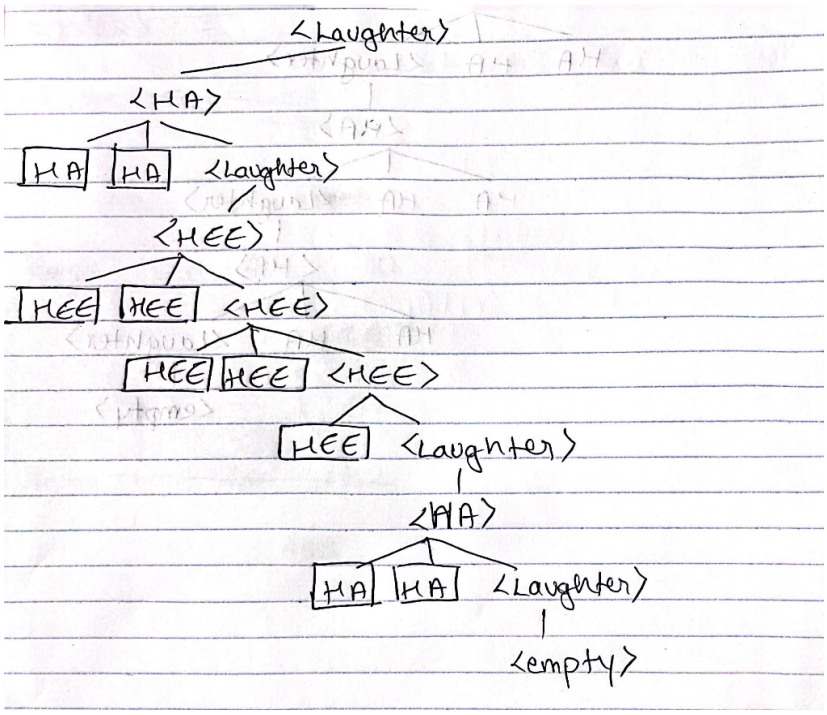
Problem 1: Laughter

BNF Grammar:

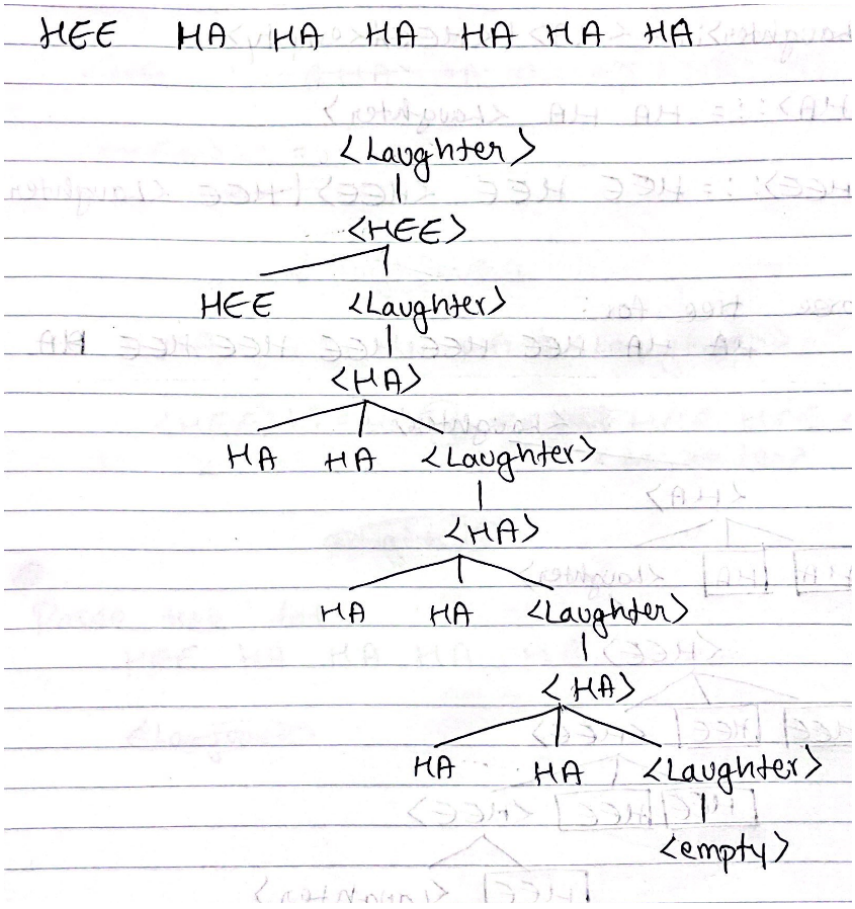
```
<Laughter> ::= <HA> | <HEE> | <empty>
<HA> ::= HA HA <Laughter>
<HEE> ::= HEE HEE <HEE> | HEE <Laughter>
```

Parse tree for:

1. HA HA HEE HEE HEE HEE HEE HA HA



2. HEE HA HA HA HA HA HA



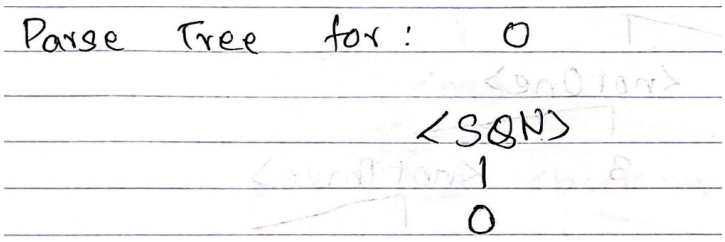
Problem 2: SQN(Special Quaternary Numbers)

BNF Grammar:

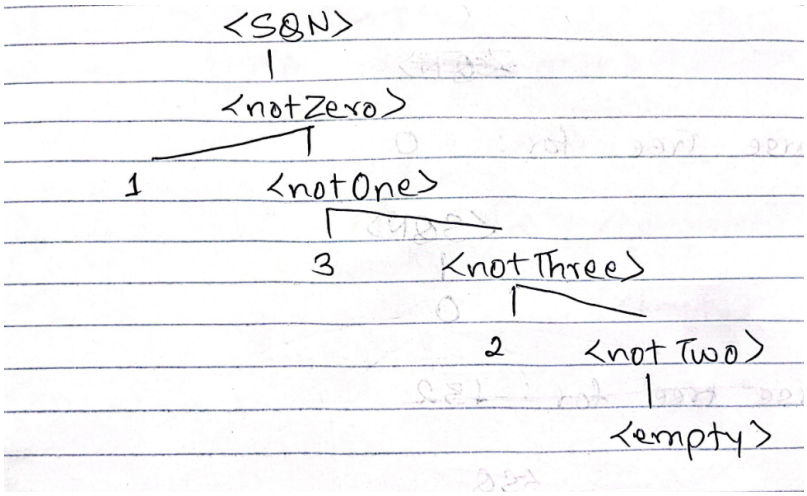
```
<SQN> ::= 0 | <notZero>
<notZero> ::= 1 <notOne> | 2 <notTwo> | 3 <notThree> | <empty>
<notOne> ::= 0 <notZero> | 2 <notTwo> | 3 <notThree> | <empty>
<notTwo> ::= 0 <notZero> | 1 <notOne> | 3 <notThree> | <empty>
<notThree> ::= 0 <notZero> | 1 <notOne> | 2 <notTwo> | <empty>
```

Parse trees for:

1. 0



2. 132



#Question: Explain, in precise terms, why you cannot draw a parse tree, consistent with the BNF grammar that you crafted, for the string: 1223

In the given string, there are two adjacent occurrences of ‘2’, which contradicts the syntax that this grammar is based on. If we give it a try, after occurrence of one ‘2’, the grammar leads to <notTwo> that makes it impossible for us to get another ‘2’ and this applies to other adjacent occurrences too.

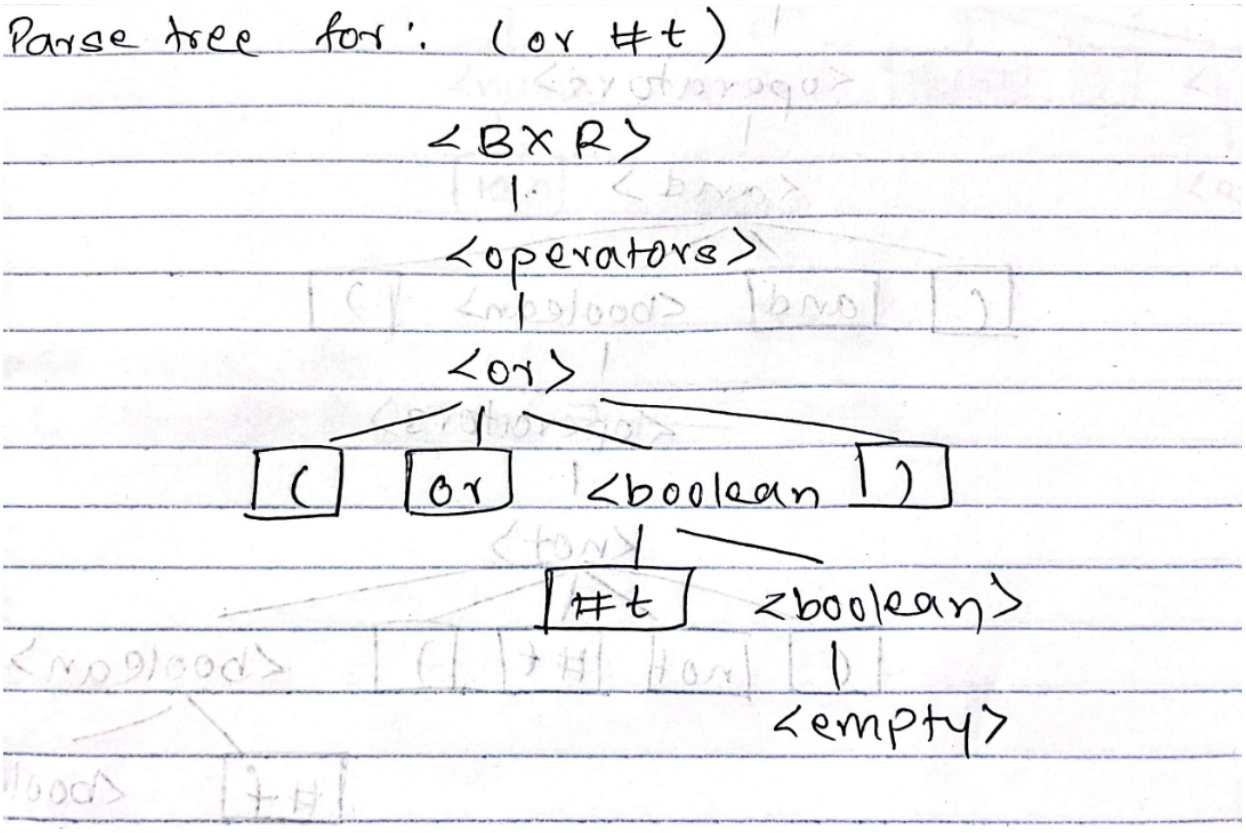
Problem 3: BXR

BNF Grammar:

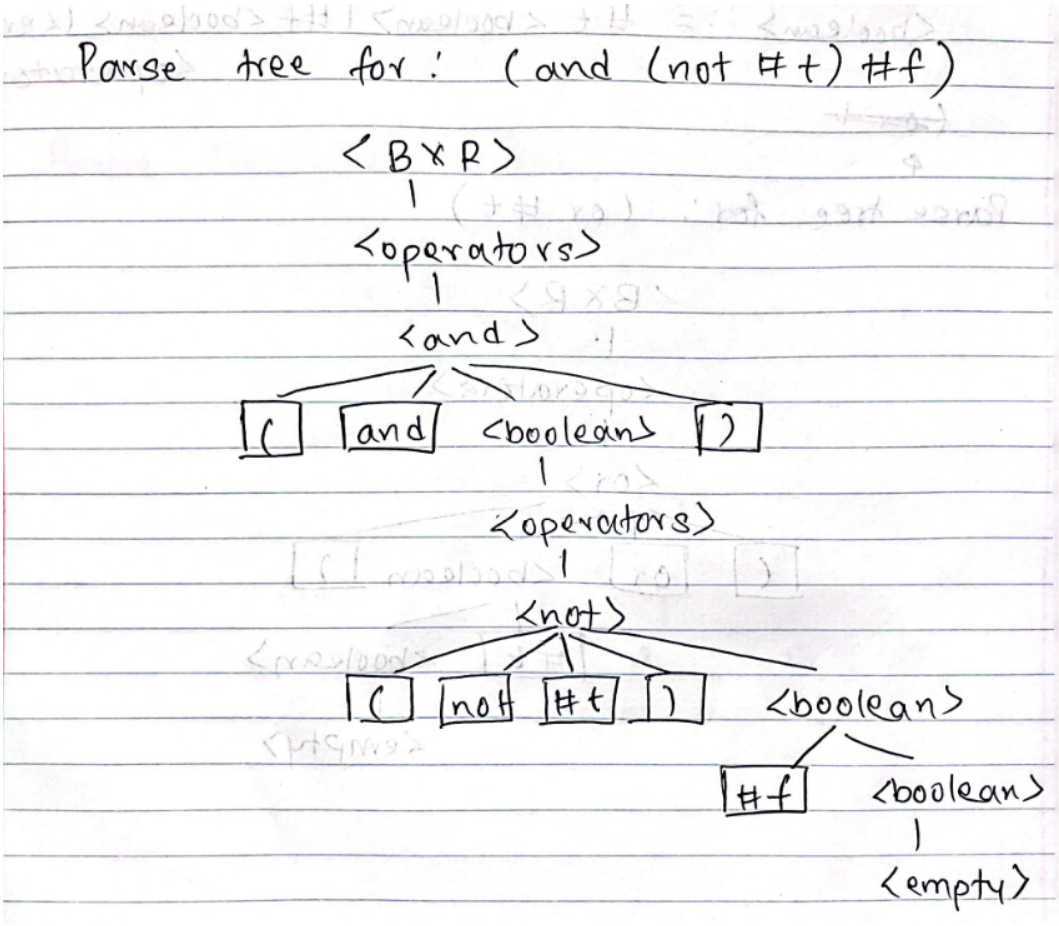
<BXR> ::= #t | #f | <operators>
<operators> ::= <and> | <or> | <not>
<and> ::= (and <boolean>) | (and)
<or> ::= (or <boolean>) | (or)
<not> ::= (not #t) | (not #f) | (not #t) <boolean> | (not #f) <boolean>
<boolean> ::= #t <boolean> | #f <boolean> | <operators> | <empty>

Parse trees for:

1. (or #t)



2. (and (not #t) #f)


Parse tree for: (and (not #t) #f)
<BXR>
<operators>
<and>
(
and
<boolean>
)
<operators>
<not>
(
not
#t
)
<boolean>
#f
<boolean>
<empty>

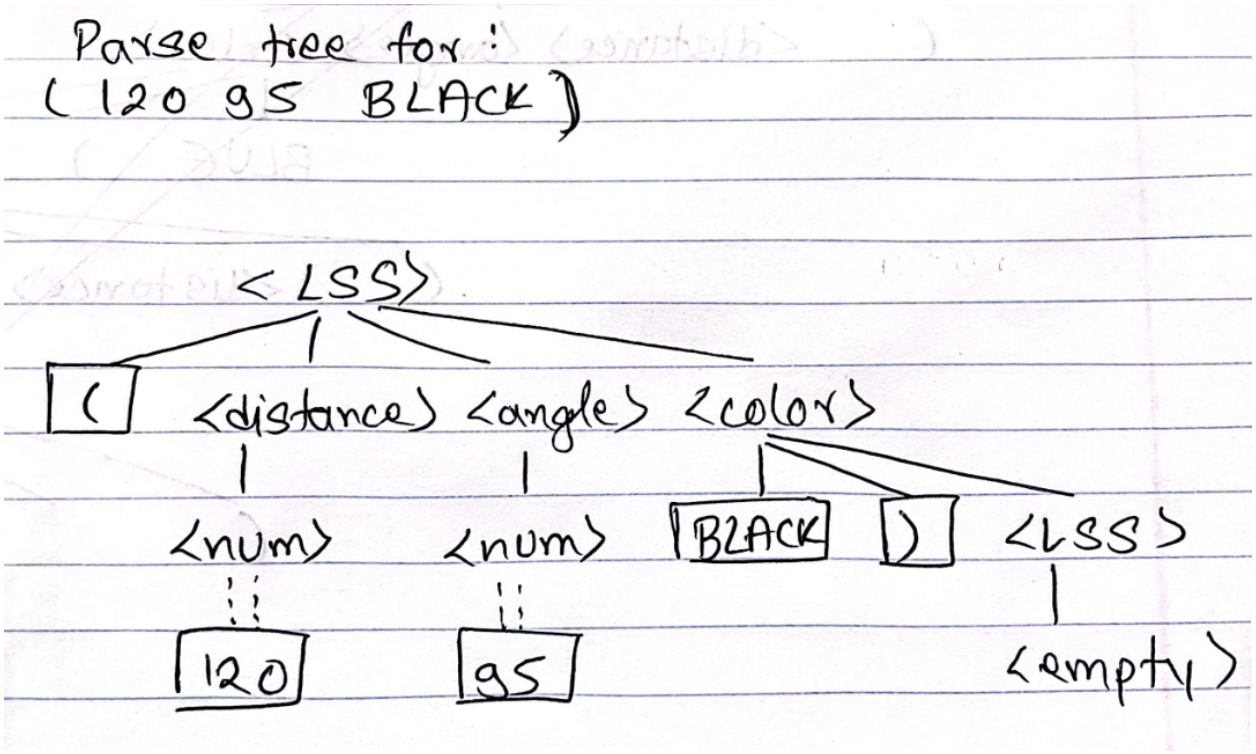
Problem 4: LSS(Line Segment Sequences)

BNF Grammar

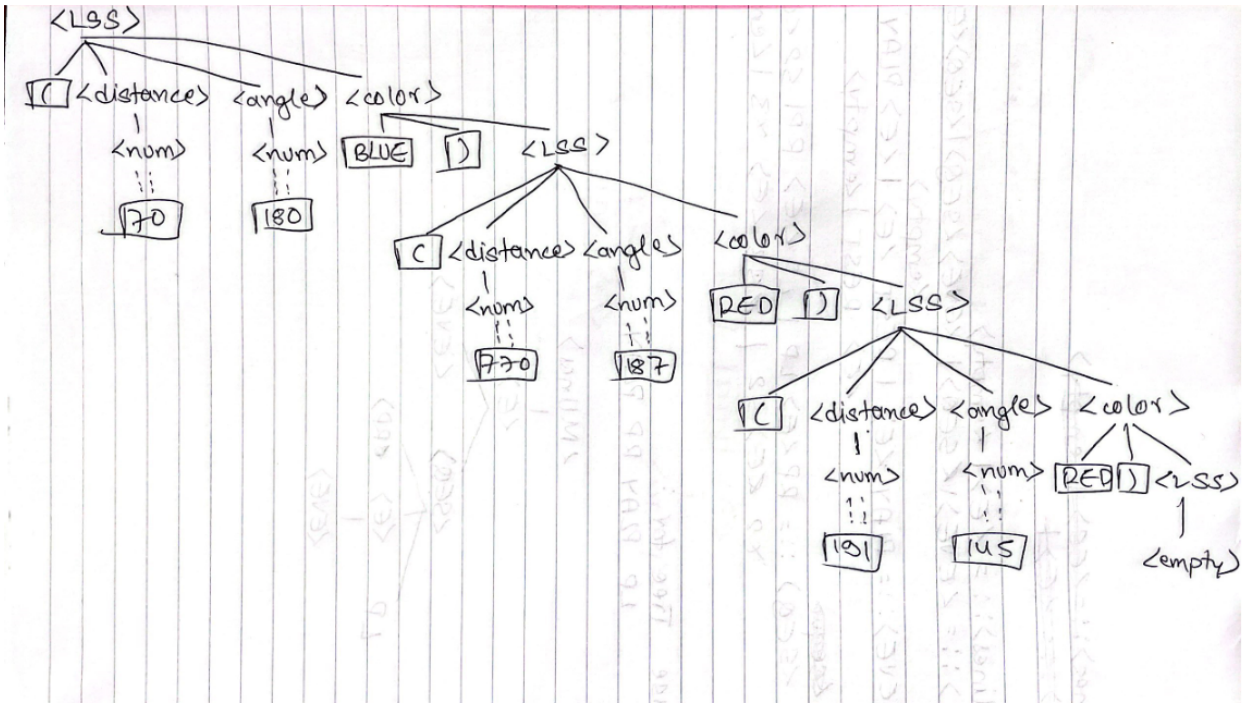
<LSS> ::= (<distance> <angle> <color> | <empty>
<distance> ::= <num>
<angle> ::= <num>
<color> ::= BLUE) <LSS> | BLACK) <LSS> | RED) <LSS>

Parse tree for:

1. (120 95 BLACK)



2. (70 180 BLUE) (770 187 RED) (191 145 RED)



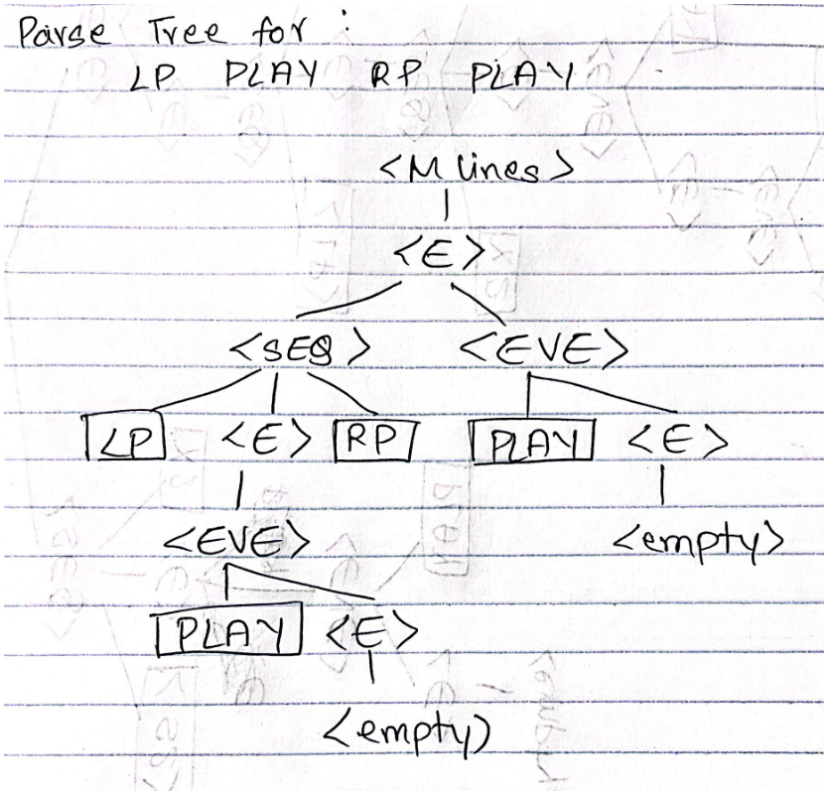
Problem 5: M-Lines

BNF Grammar

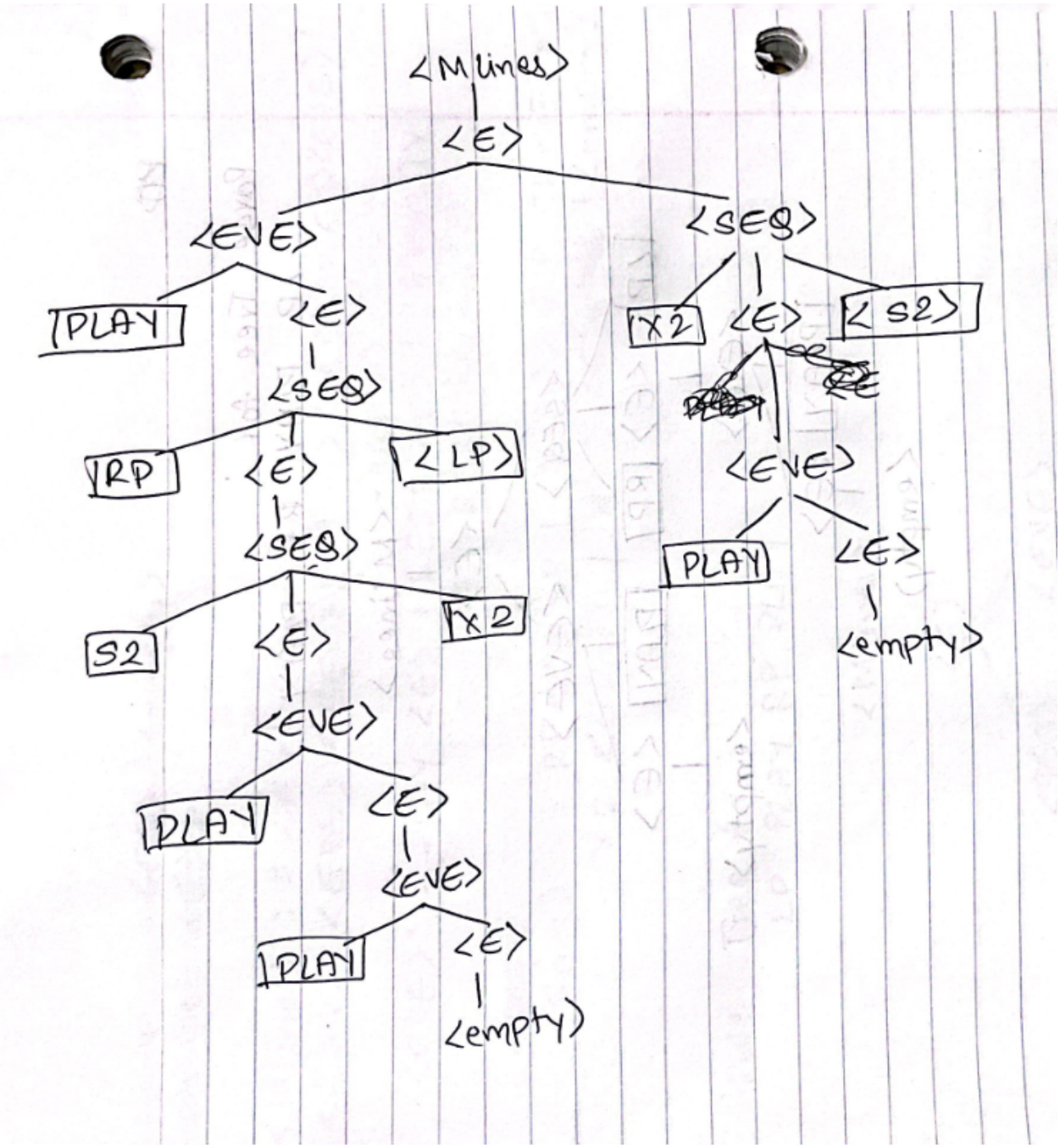
<Mlines> ::= <E> | <empty>
<E> ::= <EVE> | <SEQ> | <EVE> <SEQ> | <SEQ> <EVE> | <empty>
<EVE> ::= PLAY <E> | REST <E> | <E> PLAY | <E> REST | <empty>
<SEQ> ::= RP <E> LP | LP <E> RP | S2 <E> X2 | X2 <E> S2 | S3 <E> X3 | <empty>

Parse tree for :

1. LP PLAY RP PLAY



2. PLAY RP S2 PLAY PLAY X2 LP X2 PLAY S2



Problem 6: What is BNF?

BNF(Backus-Naur Form) is simply a mathematical way to define syntax of a programming language. It consists of specific symbols or strings, which are called terminals and non-terminals. We use those, along with a set of rules to create a set of grammar for a language. BNF has been used to develop various languages. The set of rules is written as such:

Left-Hand side ::= Right-Hand side

There can only be one non-terminal on the left-hand side but there can be multiple terminals or non-terminals on the right-hand side.