Compiler Construction — Practice Sheet

Instructions

This practice sheet is divided into **two parts**:

- **Part A:** LL(1) Parsing Practice Problems (with given input strings)
- **Part B:** Context-Free Grammar (CFG) Construction Problems

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Part A — LL(1) Parsing Practice Problems

For **each problem**, students must complete the following steps:
Step 1: Compute FIRST sets
Step 2: Compute FOLLOW sets
Step 3: Construct the LL(1) Parsing Table
Step 4: Parse the Input String using Stack
Step 5: Construct the Parse Tree

Problem 1

```
E  → T E'
E' → + T E' | ε
T  → F T'
T' → * F T' | ε
F  → ( E ) | id | num
```

Input: `id + id * num`

Problem 2

```
E  → T E'
E' → - T E' | ε
T  → F T'
T' → / F T' | ε
F  → ( E ) | id | num
```

Input: `id - id / num`

Problem 3

```
E  → T E'
E' → + T E' | - T E' | ε
T  → F T'
T' → * F T' | ε
F  → id | ( E ) | num
```

Input: `( id + num ) - id * num`

Problem 4

```
S  → id = E
E  → T E'
E' → + T E' | ε
T  → F T'
T' → * F T' | ε
F  → id | num | ( E )
```

Input: `x = id + num * id`

Problem 5

```
S  → id = E
E  → T E'
E' → - T E' | ε
T  → F T'
T' → / F T' | ε
F  → id | num | ( E )
```

Input: `y = ( id - num ) / id`

Problem 6

```
S  → id = E
E  → T E'
E' → + T E' | - T E' | ε
T  → F T'
T' → * F T' | / F T' | ε
F  → id | num
```

Input: `res = id * num + id`

Problem 7

```
E  → T E'
E' → + T E' | ε
T  → F T'
T' → * F T' | / F T' | ε
F  → ( E ) | id | num
```

Input: `( id * id ) + num`

Problem 8

```
E  → T E'
E' → + T E' | - T E' | ε
T  → F T'
T' → * F T' | / F T' | ε
F  → id | num | ( E )
```

Input: `id * ( id + num )`

Problem 9

```
S  → ( L ) | a
L  → S L'
L' → , S L' | ε
```

Input: `( a , a )`

Problem 10

```
S    → ( L ) | atom
L    → S L'
L'   → , S L' | ε
atom → id | a
```

Input: `( id , a )`

Problem 11

```
S    → ( L ) | atom
L    → S L'
```

```
L'   → , S L' | ε
atom → num | id | a
```

Input: `( num , id , a )`

Problem 12

```
E  → T E'
E' → < T E' | ε
T  → id | num | ( E )
```

Input: `id < num`

Problem 13

```
E  → T E'
E' → < T E' | ε
T  → id | num | ( E )
```

Input: `a < b < c`
(treat a,b,c as identifiers / id)

Problem 14

```
E  → T E'
E' → . T E' | ε
T  → "id" | "num"
```

Input: `"id" . "num"`

Problem 15

```
E  → T E'
E' → . T E' | ε
T  → "id" | "num" | ( E )
```

Input: `"id" . ( "num" )`

Part B — CFG Construction Problems

Instructions: For each language below, write a context-free grammar (CFG). If the language is not context-free, provide a short justification.

1. $L = \{ a^n b^n \mid n \geq 0 \}$
2. $L = \{ a^n b^m \mid n, m \geq 0 \}$
3. $L = \{ a^n b^n c^n \mid n \geq 0 \}$ ⚠ *Not context-free*
4. Palindromes over {a, b}
5. $L = \{ a^n b^n c^m \mid n, m \geq 0 \}$
6. $L = \{ a^n b^m c^m \mid n, m \geq 0 \}$
7. $L = \{ w \in \{a, b\}^* \mid w$ has even number of a's $\}$
8. $L = \{ w \in \{a, b\}^* \mid w$ has even number of b's $\}$
9. $L = \{ w \in \{a, b\}^* \mid w$ has odd number of a's $\}$
10. $L = \{ w \in \{a, b\}^* \mid w$ has odd number of b's $\}$
11. $L = \{ w \in \{a, b\}^* \mid$ number of a's = number of b's $\}$
12. $L = \{ a^n b^n c^m d^m \mid n, m \geq 0 \}$
13. $L = \{ w \in \{a, b\}^* \mid w$ starts and ends with the same symbol $\}$
14. $L = \{ w \in \{a, b\}^* \mid w$ ends with "ab" $\}$
15. $L = \{ w \in \{a, b\}^* \mid$ length of w is even $\}$
