1. Consider the context-free grammar:

   S -> S S + | S S * | a
   and the string aa + a*.

   1. Give a leftmost derivation for the string.

      S =leftmost

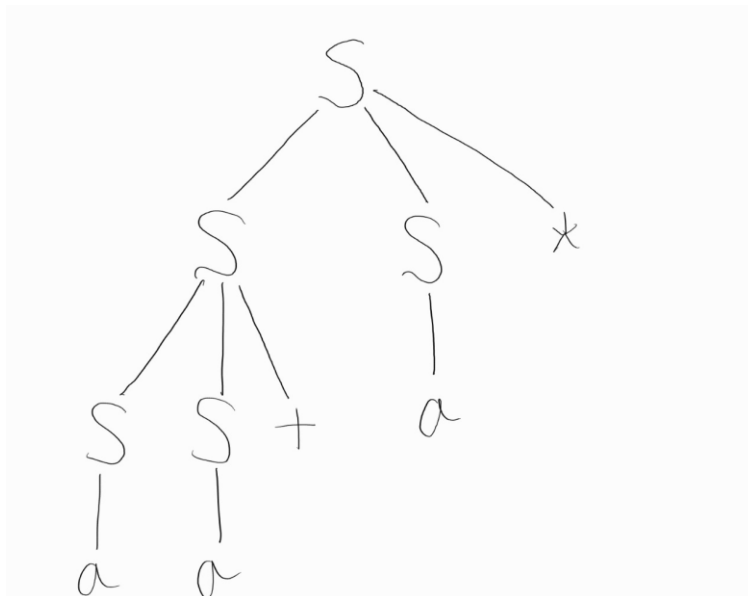   **=> SS* => SS+S* => aS+S* => aa+S* => aa+a***

   2. Give a right most derivation for the string.

      S =rightmost

      => SS* => Sa* => SS+a* => Sa+a* => aa+a*

   3. Give a parse tree for the string.

2. Repeat 1 above for each of the following grammars and strings

   1. S->0 S 1 | 0 1 with string 000111.

      - **S =leftmost=> 0S1 => 00S11 => 000111**
      - **S =rightmost=> 0S1 => 00S11 => 000111**
      - **Parse tree**
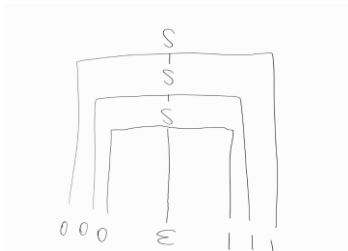
   2. S->+ S S | * S S | a with string +*aaa.

      - **S =leftmost=> +SS => +*SSS => +*aSS => +*aaS => +*aaa**
      - **S =rightmost=> +SS => +Sa => +*SSa => +*Saa => +*aaa**
      - **Parse tree**
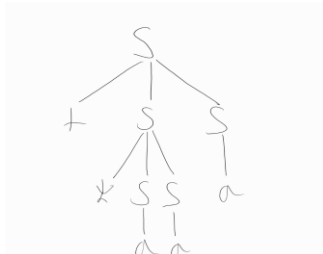
3. Answer 1,2,3, & 5

1.	The set of all strings of 0s and 1s such that every 0 is immediately followed by at least one 1.
2.	! The set of all strings of 0s and 1s that are palindromes; that is, the string reads the same backward as forward.
3.	! The set of all strings of 0s and 1s with an equal number of 0s and 1s.
4.	!! The set of all strings of 0s and 1s with an unequal number of 0s and 1s.
5.	! The set of all strings of 0s and as in which 011 does not appear as a substring.
6.	!! The set of all strings of 0s and 1s of the form xy, where x<>y and x and y are of the same length

   1. S -> (0?1)*
   2. S -> 0S0 | 1S1 | 0 | 1 | ε
   3. S -> 0S1S | 1S0S | ε
   5. S -> 1*(0+1?)*

4. There is an extended grammar notation in common use. In this notation, square and curly braces in production bodies are metasymbols (like-> or |) with the following meanings:

   1. Square braces around a grammar symbol or symbols denotes that these constructs are optional. Thus, production A -> X[Y]Z has the same effect as the two productions A -> XYZ and A -> XZ.

   2. Curly braces around a grammar symbol or symbols says that these symbols may be repeated any number of times, including zero times. Thus, A -> X{YZ} has the same effect as the infinite sequence of productions A -> X, A -> XYZ, A -> XYZYZ, and so on.

Show that these two extensions do not add power to grammars; that is, any language that can be generated by a grammar with these extensions can be generated by a grammar without the extensions.

Extended grammar	Not extended grammar
A->X[Y]Z	**A->XZ	XYZ**
A->X{YZ}	**A->XB** **B->YZB	ε**

5. Use the braces described in Exercise 4.2.4 to simplify the following grammar for statement blocks and conditional statements:

```
stmt -> if expr then stmt else stmt
      | if stmt them stmt
      | begin stmtList end
stmtList -> stmt; stmtList | stmt
```

   stmt -> if expr then stmt [else stmt]
     | begin stmtList end
   stmtList -> stmt [; stmtList]