I) Give a formal definition with any notations for each of the following: Alphabet, String, Language, Concatenation of strings, Reverse of a string, Substring, Length of a string, Star-Closure of an alphabet, Positive Closure of an alphabet, Sentence of a language

Alphabet - An alphabet Σ is a finite, nonempty set of symbols
String - a finite sequence of symbols from an alphabet
Language - a set of strings
Concatenation of strings - The concatenation of strings u and v means appending the symbols of v to the right end of the symbols of u, denoted as uv
Reverse of a string - The reverse of a string (denoted as w) is denoted as w^R. w^R is the string with the same symbols in reverse order
Substring - A substring is a sequence of consecutive characters taken from the original string to make a new string
Star-Closure of an alphabet - Σ^* for an alphabet Σ, is the set of all strings obtained by concatenating zero or more symbols from the alphabet
Positive-Closure of an alphabet - Σ^+, for an alphabet Σ, is the set of all strings from the alphabet Σ except (Lambda)
Sentence of a language - A string from a language is referred to as a sentence. For Language L: {a, aa, ab}, “a”, “aa”, “ab” are sentences

II) For a language L, describe the Complementation, and Star-Closure

Complementation - $LC = \Sigma^* - L$
Star-Closure - $L^* = L0 \cup L1 \cup L2 \cup \ldots$

III) Describe the relationship of Language, Grammar and Automata (over a given alphabet)

A language is a set of strings; a grammar is a set of rules used to define which symbols of an alphabet can be sequenced into strings of a language; and an automata is a mathematical model of a computer which can determine if a string is a part of a Language.

IV) Write derivations for four strings of various lengths and describe what is the language generated, L(G) by the following grammar G.
V = {S, A, B}
T = {a, b},
P = {
S → A,
S → B,
B → bB,
A → aA,
A → λ,

B → λ
}
S is the start nonterminal

V) Write derivations for four strings of various lengths and describe what is the language generated, L(G) by the following grammar
S → aSaa | B
B → bB | λ

VI) Write derivations for four strings of various lengths and describe what is the language generated, L(G) by the following grammar
$S \rightarrow aSaa \mid B$
$B \rightarrow bB$

VII) Describe the operation of Automaton as an Acceptor

An automaton as an acceptor operates by taking an input then giving either a yes or no output.

VIII) Let $\Sigma = \{a.b\}$ $L_1 = \{a,ab,abb)$ $L_2 = \{\lambda, b, bb\}$ Describe all the following languages as a set of strings.
(i) $L_3 = L_1 \cap L_2$

(ii) L_1L_3

(iii) L_3L_1

(iv) L_1L_2

(v) $L_1\emptyset$

(vi) $|L_1||L_3|$

(vii) $|L_1||L_2|$

(viii) $|L_1L_2|$

(ix) L_1^R

(x) L_2^R

(xi) $\sum^*$

(xii) $L_2{}^C$

(xiii) $L_1{}^0$

(xiv) $L_1{}^1$

(xv) $L_1{}^2$

(xvi) $L_2{}^2$