# 24 Lecture - CS402

# **Important Subjective**

# 1. Define the complement of a language and provide an example.

Answer: The complement of a language L over an alphabet ? is the set of all strings in ?\* that are not in L. For example, if  $L = \{a, aa, aaa\}$ , then the complement of L is  $\{?, b, ab, ba, bb, ...\}$  where ? is the empty string and b belongs to ? but not in L.

# How can the complement of a language be obtained using an automaton?

Answer: The complement of a language can be obtained by complementing the final and non-final states of the automaton representing the language. That is, if M is an automaton that recognizes L, then the complement of L can be recognized by the automaton M' = (Q, ?, ?, q0, F') where F' = Q - F.

# Is the complement of a regular language always regular? Explain.

Answer: Yes, the complement of a regular language is always regular. This can be shown by constructing a DFA for the complement language using the method described in the previous question.

# Can a language and its complement both be regular? Explain.

Answer: No, a language and its complement cannot both be regular. This is because if a language L is regular, then its complement L' is also regular. But if both L and L' are regular, then their intersection (i.e., the empty language) must also be regular. However, the empty language is not regular, so this is a contradiction.

# What is the complement of the language {?}?

Answer: The complement of the language {?} is the set of all non-empty strings over the alphabet ?.

## Can the complement of an infinite language be finite? Explain.

Answer: Yes, the complement of an infinite language can be finite. For example, if  $L = \{a^n \mid n \text{ is even}\}$ , then its complement is  $\{a^n \mid n \text{ is odd}\}$ , which is finite.

## What is the complement of the language ?\*?

Answer: The complement of the language ?\* is the empty language.

Is the complement of a context-free language always context-free? Explain.

Answer: No, the complement of a context-free language is not always context-free. This can be shown using the pumping lemma for context-free languages.

#### Can a language and its complement both be context-free? Explain.

Answer: Yes, a language and its complement can both be context-free. For example, consider the language  $L = \{a^n b^n \mid n >= 0\}$ . Both L and its complement are context-free.

## What is the complement of the language $\{a^n b^n \mid n >= 0\}$ ?

Answer: The complement of the language  $\{a^n b^n \mid n >= 0\}$  is the set of all strings that do not have the form  $a^n b^n$ , i.e.,  $\{?, a, b, ab, ba, ...\}$ .