

1989 Paper 6 Question 12

Formal Languages and Automata

Explain what is meant by

- (a) a regular expression;
- (b) a (deterministic) finite state machine.

Assuming Kleene's theorem (which states that the regular expressions and finite state machines are closely related), describe what is meant by a regular language by relating such languages to both regular expressions and to machines.

State the Pumping Lemma for regular languages.

For each of the following languages either show that the language is regular (for example by showing it would be possible to construct a finite state machine to recognise it) or use the pumping lemma to show that it is not:

- (i) the set of all words not in a given regular language L ;
- (ii) all *palindromes* over the alphabet $\{a, b, c\}$ (a palindrome is a word that is unchanged when reversed, for example, $abcbabcba$);
- (iii) if L is a regular language, the language which consists of reversals of the words valid in L ; thus if L contains the word $abcd$, then the reversed language L^R contains $dcba$;
- (iv) given regular languages L and M , the set of strings that contain within them first a substring that is part of language L , then a substring from M , arbitrary characters from the alphabet $\{a, b, c\}$ are allowed before, between and after these substrings;
- (v) given regular languages L and M , the set of strings that contain within them some substring which is part of both L and M .