Mid Semester Examination, Autumn 2003-04

Total points: 50 | September 23, 2003 | Total time: 2 hours

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1. Write regular expressions for representing the following languages over the alphabet $\{0, 1\}$: **(2×4)**

(a) $\{\alpha \mid \alpha$ starts with 0 and ends with $1\}$

(b) $\{\alpha \mid \alpha$ starts with 01 and ends with $10\}$

(c) $\{\alpha \mid \alpha$ contains 000 as a substring$\}$

(d) $\{\alpha \mid \alpha$ does not contain 000 as a substring$\}$

2. (a) Design a DFA to accept the language $\{0, 1\}^* \setminus \{11, 111\}$. **(4)**

(b) Design an NFA *with three states* to accept the language of the regular expression $0^*1^*0^*0$. **(4)**

(c) Design an ϵ-NFA to accept the set of strings over $\{0, 1\}$, that have at least one 1 in the last ten positions. **(4)**

3. Let L be a regular language and let $n \in \mathbb{N}$ be a pumping lemma constant for L.

(a) Show that any integer $n' \geqslant n$ can be used as a pumping lemma constant for L. **(4)**

(b) The *minimum pumping lemma constant* for L is the smallest *positive* integer m, such that m can be a pumping lemma constant for L. Determine the minimum pumping lemma constants for the languages over the alphabet $\{0, 1\}$, defined by the following regular expressions: **(2×3)**

(1) 01

(2) 01^*

(3) $(01)^*$

4. Prove that the following languages over the alphabet $\{0, 1\}$ are not regular. **(5×2)**

(a) $\{\alpha \mid \alpha$ is not a palindrome$\}$

(b) $\{0^i 1^j \mid i \neq j\}$

5. Which of the following languages over the alphabet $\{0, 1\}$ is/are regular? **(5×2)**

(a) $\{\alpha \mid \alpha$ contains an equal number of occurrences of 0 and $1\}$

(b) $\{\alpha \mid \alpha$ contains an equal number of occurrences of 01 and $10\}$

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