2G1505 Automata Theory

EXAMINATION PROBLEMS
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Give solutions in English or Swedish, each problem beginning on a new sheet. Write your name on all sheets. The maximal number of points is given for each problem. The course book and own notes as well as reference material are admissible at the exam.

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1. Give a deterministic finite automaton over the alphabet $\{a, b\}$ which accepts all strings containing no more than two consecutive occurrences of the same input letter. (For example, *abba* should be accepted but not *abaaab*.) [3p]

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2. Give a (as simple as possible) nondeterministic finite automaton for the language defined by the regular expression $ab^* + a(ba)^*$. Apply the subset construction to obtain an equivalent deterministic automaton. Draw the graph of this DFA, omitting inaccessible states. [6p]

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3. Draw the graph of the deterministic finite automaton with states $\{p, q, r, s\}$, initial state p, final state s, input alphabet $\{a, b\}$, and transition function defined by the equations $\delta(p, a) = q$, $\delta(p, b) = s$, $\delta(q, a) = r$, $\delta(q, b) = s$, $\delta(r, a) = r$, $\delta(r, b) = s$, $\delta(s, a) = p$, $\delta(s, b) = s$. Minimize this automaton. Show clearly the minimization steps. [6p]

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4. Consider the language: [15p]

$$L \triangleq \{x \in \{a, b, c\}^* \mid \sharp a(x) + \sharp b(x) = \sharp c(x)\}$$

   (a) Show that L is not regular.

   (b) Give a context–free grammar for L. Prove your grammar correct.

   (c) Construct an NPDA accepting L (on empty stack).

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5. Consider the language: [10p]

$$L \triangleq \{ab,\ ababb,\ ababbabbb,\ ababbabbbabbbb,\ \ldots\}$$

   (a) Show that L is not context–free.

   (b) Describe a total Turing machine accepting L. Explain the workings of your machine/algorithm. (If possible, provide a graph of its control automaton.)

Good luck!