The Open University of Sri Lanka
B. Sc. Degree Programme – Level 05
Department of Mathematics and Computer Science
Final Examination - 2009/2010
CSU 3275/PMU3293/PME5293: Automata Theory – Paper I
Duration: Two and half hours

Date: 03.07.2010   Time: 9.30 am to 12.00 noon

Answer Four Questions ONLY.

01. (a) Let Σ be an alphabet (that is, a finite set of symbols) and $a \in \Sigma$. Explain the meaning of $a*$ and Σ^*.

   (b) State whether each of the followings is true or false. Justify your answer.
     (i) $abb \in b*a*b*a*$
     (ii) $abcd \in (a(cd)*b)*$
     (iii) $101 \in ((00)*1*(10)*(11)*(01)*)*$

   (c) Check whether the languages represented by the following expressions are identical or not. Justify your answer.
     (i) $(0* \cup 1*)$ and $(0 \cup 1)*$
     (ii) $(0* \cup 1*)*$ and $(0 \cup 1)*$

02. (a) Define a deterministic finite automaton (DFA), and describe the operation of it. What is meant by a configuration of a DFA? You may use example(s) to support your answer.

   (b) Let M be a DFA. Define $L(M)$, the language recognized by M. Consider the DFA represented by the directed graph shown in Fig 2.1. What is the language recognized by it?
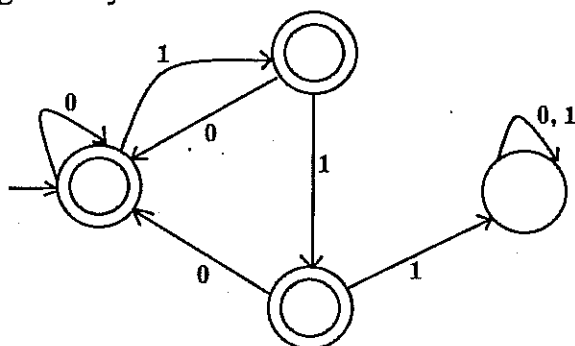

Fig 2.1

03. (a) Design a deterministic finite automaton to recognize the language L over $\{0, 1\}$ consisting of the set of all strings of the form $(1^2 \cup 0^2)*$ [**Note:** here 1^2 denotes the string 11 and 0^2 denotes the string 00].

Test your automaton with each of the following input strings.
(i) 1100
(ii) 0000
(iii) 1010

(b) A palindrome over $\{0, 1\}$ is a string over $\{0, 1\}$ that reads the same backward as forward. For example, the string 1101011 is a palindrome whereas 110001 is not. Explain why a palindrome cannot be represented by a DFA.

04. (a) Distinguish between Moore and Mealy machines.

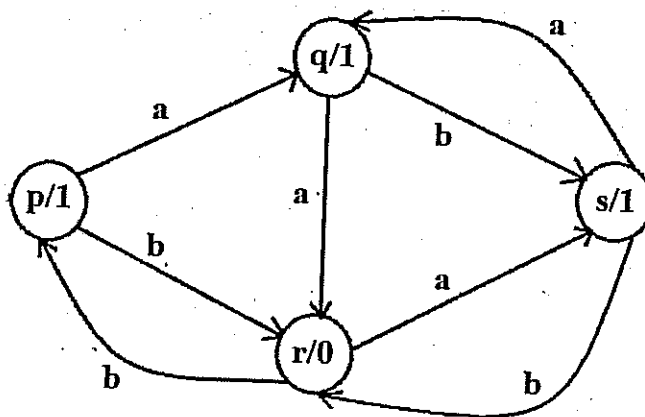Transform the Moore machine depicted in Fig 4.1 into an equivalent Mealy machine.

Fig 4.1

(b) Design nondeterministic finite automata recognizing the following languages over $\{a, b\}$.

(i) The set of all strings that start with an a.
(ii) The set of all strings containing the substring bb.

05. Let $M_1 = (S_1, I_1, O_1, \delta_1, \beta_1)$ and $M_2 = (S_2, I_2, O_2, \delta_2, \beta_2)$ be two Mealy machines, and let κ be a function from O_1 to I_2. Define the serial composite $M_1 \oplus_\kappa M_2$ of M_1 and M_2 with respect to κ.

Let M_1 and M_2 be the Mealy machines defined in Table 5.1 and Table 5.2 respectively.

	$\delta(s, i)$			$\beta(s, i)$		
	a	b	c	a	b	c
s	s	t	t	2	1	1
t	t	s	s	0	2	0

Table 5.1 – Mealy machine M_1

	$\delta(s, i)$		$\beta(s, i)$	
	a	b	a	b
s	s	t	1	2
t	t	s	2	2

Table 5.2 – Mealy machine M_2

The function κ is defined by $\kappa(0) = a$, $\kappa(1) = a$, $\kappa(2) = b$.

Construct $M_1 \oplus_\kappa M_2$.

06. (a) Design a deterministic finite automaton to recognize decimal numbers, in non-scientific notation, with or without a sign. For example, the numbers +3.241, 92, and -0.23 are in such notation while the numbers 2. and .014 are not. State any assumption you make with regards to your design.

(b) Modify your DFA in part (a) to recognize decimal numbers in scientific notation. In the scientific notation, the decimal point is placed after the first nonzero digit. For example, the numbers +4.091E-3, -2.001E5 and 5.122E-8 are in scientific notation while 23.123E-2 and -0.123E+2 are not. State any assumption you make with regards to your design.

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