B.Sc. Engg. CSE 7rd Semester — 28 February 2020 (Morning)

# ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
## ORGANISATION OF ISLAMIC COOPERATION (OIC)
## Department of Computer Science and Engineering (CSE)

**MID SEMESTER EXAMINATION** — **WINTER SEMESTER, 2019-2020**

**DURATION: 1 Hour 30 Minutes** — **FULL MARKS: 75**

## CSE 4703: Theory of Computing

**Programmable calculators are not allowed. Do not write anything on the question paper.**

There are **3 (three)** questions. Answer **all** of them.

Figures in the right margin indicate marks.

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1. a) Define Finite Automata. What are the differences between a DFA and an NFA? 2+3

   b) Give the formal description of the finite automata pictured in Figure 1. What is the language of the automata? 6+2

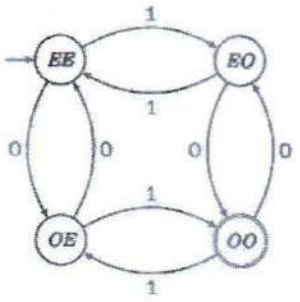


Figure 1: State diagram of a finite automaton for Question 1.b

   c) A vending machine is an automated machine that provides items such as snacks, beverages, lottery tickets to consumers after money, a credit card or specially designed card is inserted into the machine. Consider a very simple vending machine which provides pen at a cost of 10tk each. The machine takes 2tk, 5tk and 10tk only, and does not return changes even if you pay more than the price of a pen. It accepts payment only if you pay at least or more than the rate for a pen otherwise rejects. There is a reset button in the machine which someone can press anytime to start a new purchase. Now design a DFA (state diagram) for the vending machine. 12

2. a) i. Define Alphabet and String 2+3

   ii. Explain the differences among $\Sigma$, $\Sigma^0$ and $\Sigma^1$.

   b) Design an NFA to accept the set of strings over alphabet $\{0, 1\}$ such that there are two 0's separated by a number of positions that is a multiple of 4. Note that 0 is an allowable multiple of 4. 8

   c) Consider the following $\epsilon$-NFA. 12

Table 1: Transition table of an $\epsilon$-NFA for Question 2.c

| | $\epsilon$ | $a$ | $b$ | $c$ |
|---|---|---|---|---|
| $\rightarrow p$ | $\{q, r\}$ | $\emptyset$ | $\{q\}$ | $\{r\}$ |
| $q$ | $\emptyset$ | $\{p\}$ | $\{r\}$ | $\{p, q\}$ |
| $*r$ | $\emptyset$ | $\emptyset$ | $\emptyset$ | $\emptyset$ |

   i. Compute the $\epsilon$-closure of each state

   ii. Give all the strings of length three or less accepted by the automaton

   iii. Convert this automata to DFA

3. a) Write regular expressions for the following languages: 2×4

   i. The set of strings of 0's and 1's whose number of 0's is divisible by five.

   ii. The set of strings of 0's and 1's with at most one pair of consecutive 1's.

b) Describe the languages of the following regular expressions: 2×4

i. $(1+\varepsilon)(00^*1)^*0^*$

ii. $(0^*1^*)^*000(0+1)^*$

c) Convert the following DFA to a regular expression, using the state-elimination technique. 6

Table 2: Transition table of a DFA for question 3.c

| | 0 | 1 |
|---|---|---|
| →*p | s | p |
| q | p | s |
| r | r | q |
| s | q | r |

d) Convert the regular expression (0+1)01 to an NFA 3