ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **WINTER SEMESTER, 2022-2023**

DURATION: 1 HOUR 30 MINUTES **FULL MARKS: 75**

CSE 4309: Theory of Computing

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

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

---

1. a) State the differences between a DFA and an NFA. 3 (CO1) (PO1)

   b) Design a DFA for the language accepting strings ending in either '01' or '10' over input alphabet, $\sum = \{0, 1\}$. 6 (CO2) (PO3)

   c) Design an NFA to recognize '0101', '101' and '011' over input alphabet, $\sum = \{0, 1\}$. 6 (CO2) (PO3)

   d) The classic game Pac-Man requires the player to navigate through a maze, eating pellets, and avoiding the ghosts who chase him through the maze. Occasionally, Pac-Man can turn the tables on his pursuers by eating a power pellet, which temporarily grants him the power to eat the ghosts. When this occurs, the ghosts' behavior changes and instead of chasing Pac-Man, they try to avoid him. The ghosts in Pac-Man have four behaviors: randomly wander the maze, chase Pac-Man when he is within line of sight, flee Pac-Man after Pac-Man has consumed a power pellet, and return to the central base to regenerate.
   Draw the state diagram of a Finite Automata that emulates the behavior of the ghosts in Pac-Man. Show the states that the ghosts might be in at any given moment and also what inputs they take to make a transition from one state to another state. 10 (CO2) (PO2)

2. a) Give the formal definition of a Finite Automata. Explain δ for DFA, NFA, and ϵ-NFA. 3 (CO1) (PO1)

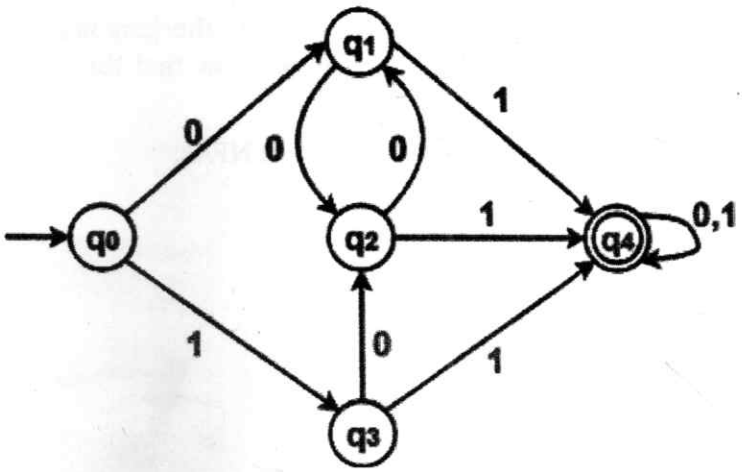

Figure 1: DFA State Diagram for Question 2.b)

   b) Consider the DFA shown in Figure 1 and minimize it using Equivalence Theorem. 7 (CO3) (PO2)

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 a specially designed card inserted into the machine. Consider a very simple vending machine which provides a pen at a cost of 10 Bangladeshi Taka (BDT) 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 it rejects the payment. There is a reset button in the machine that someone can press anytime to start a new purchase. Now for this vending machine, design a state diagram of DFA. 8 (CO2) (PO3)

d) Compute the ϵ-closure of each state and convert the ϵ-NFA shown in Table 1 to an equivalent DFA. 7 (CO5) (PO1)

Table 1: Transition table for Question 2.d)

	ϵ	a	b	c
$\rightarrow p$	$\emptyset$	$\{p\}$	$\{q\}$	$\{r\}$
q	$\{p\}$	$\{q\}$	$\{r\}$	$\emptyset$
$*r$	$\{q\}$	$\{r\}$	$\emptyset$	$\{p\}$

3. a) What is the order of precedence followed by the operators of the regular expression? Using Pumping lemma of regular languages, show that language L= $\{ a^n b^n \mid n \geq 0\}$ is not regular. 2 + 5 (CO1) (PO1)

b) Convert the following NFA shown in Table 2 to an equivalent DFA and informally describe the language it accepts. 6 (CO5) (PO1)

Table 2: Transition table for Question 3.b)

	0	1
$\rightarrow p$	$\{p, q\}$	$\{p\}$
q	$\{r, s\}$	$\{t\}$
r	$\{p, r\}$	$\{t\}$
$*s$	$\emptyset$	$\emptyset$
$*t$	$\emptyset$	$\emptyset$

c) You are given an NFA, N1=(Q1,$\sum$,δ1,q1,F1) that accepts the language A, and an NFA, $N2 = (Q2, \sum, \delta 2, q2, F2)$ that accepts the language B. Show that there exists an NFA, N that recognizes the language $A \cdot B$. 6 (CO1) (PO1)

d) Convert the following Regular Expressions to equivalent NFAs: 3 + 3 (CO5) (PO1)

i. $(0 \cup 10)^* 010 (0 \cup 1)^*$

ii. $a (abb)^* \cup b$