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

MID SEMESTER EXAMINATION **WINTER SEMESTER, 2021-2022**

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.

Answer **all 3 (three)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

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1. a) Explain if each of the following assertion is *correct* or *incorrect*. 2×4=8 (CO1) (PO2)

   i. *Deterministic Finite Automata* (DFA) are strictly weaker classes of machines than *Non-deterministic Finite Automata* (NFA), i.e., there exists a language that is accepted by an NFA and not by any DFA.

   ii. $a^n b^m$ is a regular language, where the alphabet is a, b and $n \geq 0$, $m \geq 0$.

   iii. The regular expressions $(a^*b^*)^*$ and $(a+b)^*$, represent the same language, where $\sum = \{a, b\}^*$

   iv. Considering the languages $L_1 = \emptyset$ and $L_2 = \{1\}$, the strings are accepted by the language $L_1^{\circ} L_2^* + L_1^*$ is $\{\varepsilon, 1\}$.

   b) Prove that if L, M and N are any languages, then $L(M+N) = LM + LN$. 7 (CO1) (PO1)

   c) Consider the following NFA shown in Figure 1. Convert this NFA into an equivalent DFA. Your answer should be the state diagram of a DFA. Your diagram should include only the states that are reachable from the *start* state. 10 (CO1) (PO2)

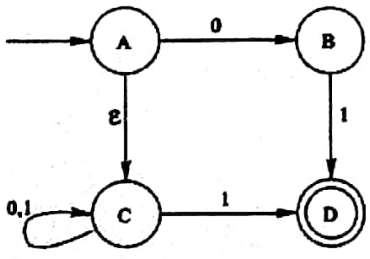

Figure 1: NFA for the question no. 1. (c)

2. a) Assume that the NFA, N_1 recognizes language, L_1; and N_2 recognizes language, L_2. Construct the NFA N to recognize the language, $L_1{}^{\circ}L_2$. Use the *proof by construction* and also draw the *schematic diagram* for the new machine N. — 9 (CO1) (PO1)

b) Convert the given DFA in Figure 2 over $\sum = \{a, b\}$ into regular expression. — 8 (CO1) (PO2)

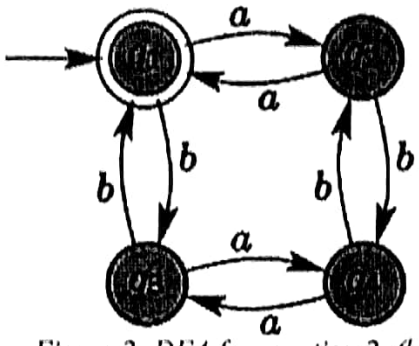

Figure 2: DFA for question 2. (b)

c) Design the DFA/NFA for the following regular expression R over $\sum = \{a, b\}$. — 8 (CO1) (PO2)

$$R = (ab)^* + (a + ab)^* b^* (a + b)^*$$

3. a) Design the regular expression for the following languages over the alphabet $\Sigma = \{0, 1\}$. — 3×3=9 (CO1) (PO2)

i. $L_1 = \{w \mid w \text{ consists of at least one '00' and '11' and not divisible by 2}\}$.

ii. $L_2 = \{w \mid w \text{ starts and ends with 1}\}$.

iii. $L_3 = \{w \mid \text{in } w, \text{the number of '1's is exactly 3 and it must end with one or more '0's}\}$.

b) Design a *Finite Stat Machine* that accepts strings in which the number '1' is congruent to 1 *mod* 3 over the alphabet $\sum = \{0, 1\}$. — 8 (CO1) (PO2)

c) Apply the pumping lemma to prove that the language L over the alphabet $\{a, b\}$ is not regular $L = \{ww : w \in \{a, b\}^*\}$. — 8 (CO1) (PO1)