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

WINTER SEMESTER, 2022-2023 SEMESTER FINAL EXAMINATION FULL MARKS: 150 DURATION: 3 HOURS

CSE 4309: Theory of Computing Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all 6 (six) questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

a) Provide a comparative analysis of Finite Automata, Pushdown Automata, and Turing Machine.

b) Finite Automata are good models for computer with an extremely limited amount of memory. The controller for an automatic door is one such example. Design and explain the informal picture of this Finite Automata with the required states and input conditions.

c) Assume the password policy for creating a student account is set as follows:

Password should start with symbols like !, #, \$, @.

Password should contain at least one upper case letter or at least one digit as substring.

· Password can contain zero or more number of lower case letters. Derive the regular expression that generates the passwords based on the policies mentioned above and design a Finite Automata that accepts the strings generated by the regular expres-

a) Explain δ for DFA, NFA, and ε-NFA.

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 b) The World Health Organization (WHO) has designated COVID-19 as an airborne disease. prompting a reconsideration of human-to-human testing due to potential risks. Consequently, a robotic testing system has been devised with the following operational procedure: The individual being tested exhales in proximity to the robot's sensor. If the pressure is insufficient, they are instructed to exhale again. Subsequently, a viral presence assessment is conducted. If positive, the individual is instructed to place their forehead near the temperature sensor of the robot. If an elevated temperature is detected, an alarm is triggered, and appropriate authorities facilitate the individual's transportation to a medical facility. Conversely, if the temperature is within the normal range, the robot provides guidance for the

individual to observe a 14-day home quarantine. Design a Finite Automaton to represent the sequence of operations of the robotic system.

c) Considering the ε-NFA shown in Table 1, compute the ε-closure of each state and convert it to an equivalent DFA.

Table 1: Transition table for Question 2.c)

	c	a	b	c
$\rightarrow p$	{q,r}	Ø	{q}	{r}
q	ß	{p}	{r}	{p,q}
	Ø.	(A)	- 65	CE.

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10 (PO1)

(PO2)

(CO2)

(PO2)

(CO1)

12

(PO3)

3. a) What are the closure properties of Engular Languager Using Pumping lemma of Regular Languages, show that language L = [0 T ²] no. 1] is not regular. b) You are given an NSIA, N1 − (0.07), £3, 4], F10 − 1] is not regular. h) You are given an NSIA, N1 − (0.07), £3, 4], F10 that accepts the language A, and an NFA, N that N2 − (0.27), £3, 42, F10 that accepts the language A. (CCO) (COO) c) What is Chomolay Normal Form (CNF) Simplify the following grammar and put the resulting grammar into CNF. S → aAa bBb c A → C a B → C b C → CDB c D → A B ab A → B Bplain ambiguous grammar. How can you remove ambiguity from a grammar? (COO) b) Design a Paulsdown Automata which accepts the ill/else errors by empty stack and show the moves for the input string w = iieee. c) Show that the following grammar is ambiguous on the string auablecedd. S → AB C A → Ca ab B → cBd cd C → aCd abd D → bDc be 5. a) Explain Decidability, Undeeddability, and others constructed a simulate it on the input string 0100000. (COO) (COO) (COO) (COO) (COO)
b) You are given an NFA, N1 = (Q1, ∑, 51, q1, F1) that accepts the language A, and an NFA, N2 = (Q2, ∑, 52, q2, F2) that accepts the language A. Show that there exists an NFA, N that (CC1) (PO1) (PO2) (PO3) (PO4) (PO3) (PO4) (
N2 = (Q2, ∑, 9, 4, 4, 2, 1) and accept one accepts the lifebox errors plan and put the result of the Inaquigat A \(\text{V} \). (S) What is Chemaky Normal Form (CNFF) Simplify the following grammar and put the resulting grammar into CNF. S → \(\text{A} = \(\text{L} \) S A \(\text{A} \) = \(\text{L} \) C − (DE \(\text{L} \) D → A \(\text{L} \) B \(\text{L} \) A = \(\text{L} \) C − (DE \(\text{L} \) D → A \(\text{L} \) B \(\text{L} \) (O1) (O2) (O3) (O4) 4. a) Explain ambiguous grammar. How can you remove ambiguity from a grammar? (O4) (O5) (O5) (O6) (O7) (O
c) What is Chomisly Normal Form (CNF)? Simplify the bollowing grammar and part (CNF) ing grammar into CNF. S → α A = δ b b c S → α A = δ b b c C → CDF c C → CDF c D → A B ab 4. a) Explain ambiguous grammar. How can you remove ambiguity from a grammar? (CO1) (CO1) (FO1) b) Design a Pushdown Automata which accepts the lifelise errors by empty stack and show the moves for the input string w = lifer. (CO2) (CO3) (CO3) (FO3) S → A B C C → CD ab D → B D ab D → B D b b c S → A B c D → B D b c S → B c C → CD ab D → B D b c S → B c C → CD ab D → B D c b c S → B c D → B D c b c S → B c C → CD c c D → B D c c S → B c D → B D c c D → B D c c D → B D c c D → B D c c D → B D c c D → B D c c D → D c c D → D c c D → D c c D → D c c D → D c c D → D c c D → D c c D → D c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c D → D c c c c D → D c c c D → D c c c c D → D c c c c D → D c c c c D → D c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c c c c c D → D c
$S \rightarrow aAa$ [1809] f $A \rightarrow C$ $B \rightarrow C$ $A \rightarrow C$ $B \rightarrow C$ $A \rightarrow C$ $B \rightarrow C$ $A \rightarrow$
$B \rightarrow C \mid b$ $C \rightarrow CDE \mid c$ $D \rightarrow A \mid B \mid ab$ 4. a) Explain ambiguous grammar. How can you remove ambiguity from a grammar? (5) (701) (701) (701) (701) (701) (702) (703) (704) (704) (705) (705) (705) (706) (706) (707) (707) (708) (708) (709)
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C \rightarrow CDE c $D \rightarrow A \mid B \mid$ ab $D \rightarrow A \mid B \mid$ and $D \rightarrow A$
A B ab A ab ab ab A
4. a) Explain ambiguous grammar. How can you remove ambiguity from a grammar? (CO1) b) Design a Pududown Automata which accepts the ill/else errors by empty stack and show the moves for the input string w = lieve. c) Show that the following grammar is ambiguous on the string audbecedd. S → 4.8 C (CO2) A → 4.8 ab B → 6.8 ob C → 6.0 ab D → 5.0 be 5. a) Explain Decidability, Undecidability, and Intractability. (CO1) b) Construct a FDA equivalent to the following CFG and simulate it on the input string 010000. (CO2)
(PO1) Design a Pushdown Automata which accepts the lifelse errors by empty stack and show the moves for the input string w = lieve. (CO2) c) Show that the following grammar is ambiguous on the string aubbecedd. S → AB C A → AB ab B → GB ob C → aC d aDd D → BDc bc 5. a) Explain Decidability, Undecidability, and Intractability. (DO3) CO3) (DO3) CO3) (DO3) 10 CO3) CO3) (DO3) CO3) (DO3)
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c) Show that the following grammar is ambiguous on the string dataneous. (CO3) $S \to AB \mid D \qquad (CO3)$ $A \to aAb \mid ab \qquad (CO3)$ $B \to cBd \mid cb \qquad (CO3)$ $C \to aCd \mid aDd \qquad (CO3)$ $D \to Dbc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$ $S \to ab \mid Dc \mid bc \qquad (CO3)$
$S \rightarrow AB \mid C$ (POS) $A \rightarrow AB \mid ab$ $B \rightarrow BB \mid cb$ $C \rightarrow GC \mid aDD \mid$ $D \rightarrow bDc \mid bc$ 5. a) Explain Decidability, Undecidability, and intractability: (POS) (POS) (POS) (POS) (POS) (COS) (COS)
$S \rightarrow AB \mid C$ (POS) $A \rightarrow AB \mid ab$ $B \rightarrow BB \mid cb$ $C \rightarrow GC \mid aDD \mid$ $D \rightarrow bDc \mid bc$ 5. a) Explain Decidability, Undecidability, and intractability: (POS) (POS) (POS) (POS) (POS) (COS) (COS)
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(POI) b) Construct a PDA equivalent to the following CPG and simulate it on the input string 010000. (COS)
b) Construct a PDA equivalent to the following CPG and simulate it on the input string 010000. 12 (COS)
 b) Construct a PDA equivalent to the following CFG and simulate it on the input string 010000. 12 (COS) S → 0.88
b) Construct a PDA equivalent to the solutions (COS) S → 0BB (COS)
$B \rightarrow 0S \mid 1S \mid 0$
c) If $L = N(P_N)$ for some PDA $P_N = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$, then prove that there is a PDA, $P_F = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$, then prove that there is a PDA, $P_F = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$, then prove that there is a PDA, $P_F = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$, then prove that there is a PDA, $P_F = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$, then prove that there is a PDA, $P_F = (Q, \sum_i \Gamma_i \delta_N, q_0, Z_0)$.
c) If $L = N(P_N)$ for some PDA $P_N = (Q, \sum_i 1, \delta_N, q_0, \delta_0)$, and prove that
such that $L = L(P_F)$. (PO3)
a) Why Turing Machines are Deterministic? What are the 7 tuples of a Turing Machine? (CO1)
(P01)
7
b) How can you simulate a Turing Machine by using a computer? (CO1)
(PO1)
c) Design a Turing machine for the language $L = a^n b^n c^n n \ge 1$ with transition diagram and (CO2)
 c) Design a Turing machine for the language L = a o t = p = 1 white the language L = a o t = 1 white the language L = a o t = 1 white the language L = a o t = 1 white the language L = a o t = 1 white the language L = a o t = 1 white the language L = a o t = 1 white the language L = a o t = 1 w
show the tape movements for the string $w = uabbec.$ (PO3)