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(Deemed to be University)

Assignment

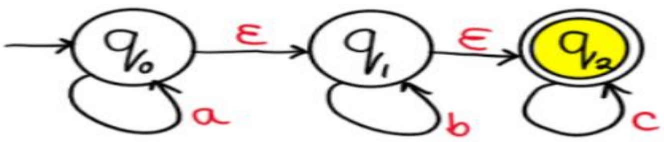
Branch	**CSE/CSIT**	Programme	**B.Tech**
Course Name	**Introduction to the Theory of Computation**	Semester	**5^{th}**
Course Code	**CSE3731**	Academic Year	**2024-25**

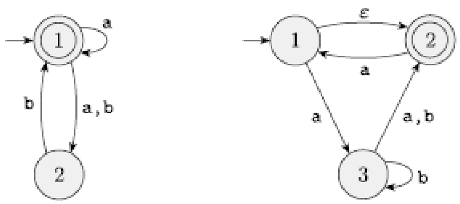
ASSIGNMENT - 1

Submission due date: **09/11/2024**

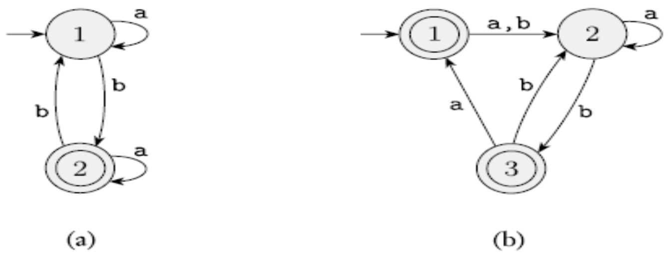
Learning Level (LL)	**L1**: Remembering	**L3:** Applying	**L5**: Evaluating
	L2: Understanding	**L4**: Analysing	**L6**: Creating

Q's	Questions	COs	LL
1	a. What are the key differences between complexity theory, computability theory, and automata theory, and how do their concepts interrelate in defining the limits of computation? b. What are the differences between an alphabet, a string, and a language in automata theory? Include examples to illustrate these concepts. c. Differentiate between the Kleene star closure (Σ*) and Positive closure (Σ^+) with suitable examples.	**CO1**	**L1,L2, L4**
2	a. Let S(n)= 1 + 2 + 3 + - - - + n be the sum of the first n natural numbers and let C(n) = $1^3 + 2^3 + 3^3 + - - - + n^3$ be the sum of the first n cubes.Prove the following equalities by induction on n, to arrive at the curious conclusion that C(n) = S^2(n) for every n. i. S(n)=$\frac{1}{2}n(n+1)$ ii. C(n)= $\frac{1}{4}(n^4+2n^3+n^2)=\frac{1}{4}n^2(n+1)^2$ b. Proof by contradiction that √5 is irrational. c. Show that every graph with ≥ 2 nodes contains two nodes that have equal degrees.	**CO1**	**L1, L3,L4**
3	a. A graph G is said to be k-regular if every node in the graph has degree k. Construct a 3-regular graph G = (V, E) with 12 nodes. Display the vertex set V and edge set E of the graph G. b. For a K-regular graph, if K is odd, then the number of vertices of the graph must be even. TRUE/FALSE? Justify your answer by constructing a suitable graph c. Using proof by construction, show that "For each even number N>=2, there exist a 3-regular graph with N vertices". d. Number of edges of a K-regular graph with N vertices is |E| = (N*K)/2. Write down the formula to construct the edges of a 3-regular graph.	**CO1**	**L3**
4	Design the DFA's recognizing the following languages over input alphabets Σ = {0, 1}. a) {All strings except the empty string} b) {w | w contains an even number of 0s or contains exactly two 1s} c) {w | w has length at least 3 and its third symbol is a 0} d) {w | w has length 4 and every string contains at least two 0s}	**CO2**	**L2,L3**
5	In certatin programming languages, comments appear between delimiters such as / * and */. Let C be the language of all valid delimited comment strings. A	**CO2**	**L4, L5**

<table>
<tr><td></td><td>member of C must begin with /* and end with */ but have no intervening */. For simplicity, assume that the alphabet for C is Σ= {a, b, /, *}
a) Construct a Finite Automata that recognizes C.
b) Define a regular expression that generates C.</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>a. Design a NFA that accepts the language L={w | w contains at least two 0’s and at most one 1 over input alphabets Σ={0, 1}}
b. Convert the following ϵ-NFA to equivalent DFA and identify the language that is recognized by the DFA.


c. Design a DFA for the transition table as given below and determine the language that is recognized by the DFA.
<table><tr><th>Present State</th><th>0</th><th>1</th></tr><tr><td>→q0 (initial)</td><td>{q0, q1}</td><td>{q0, q2}</td></tr><tr><td>q1</td><td>{q3}</td><td>φ</td></tr><tr><td>q2</td><td>{q2, q3}</td><td>{q3}</td></tr><tr><td>q3 (final)</td><td>{q3}</td><td>{q3}</td></tr></table></td><td>CO2</td><td>L2,L3</td></tr>
<tr><td>7</td><td>Use state construction method to convert the following two nondeterministic finite automata to equivalent deteministic finite automata.


(a) (b)</td><td>CO2</td><td>L3</td></tr>
<tr><td>8</td><td>Let Σ = {a, b}.
i) Write regular expression to define language consisting of strings ‘w’ such that, ‘w’ contains only a’s or only b’s of length zero or more.
ii) Write regular expression to define language consisting of strings ‘w’ such that, ‘w’ is of length one or more and contains only a’s or only b’s.
iii) Write regular expression to define language consisting of strings ‘w’ such that, ‘w’ of length odd containing only b’s
iv) Write regular expression to define language consisting of strings ‘w’ such that, ‘w’ contains zero or more a’s followed by zero or more b’s
v) Write regular expression to define language consisting of strings ‘w’ such that, ‘w’ always starting with a.</td><td>CO2</td><td>L3</td></tr>
<tr><td>9</td><td>a. Convert the following regular expressions to nondeterministic finite automata.
i) (0 U 1)* 000 (0 U 1)*
ii) (((00)*(11)) U 01)*
iii) Φ*</td><td>CO2</td><td>L3</td></tr>
</table>

	b. Convert the following finite automatons to regular expressions. 		
10	Use the pumping lemma to show that the following languages are not regular. a) L1={$0^n1^n2^n$ | n ≥ 0} b) L2={www | w ∈ {a , b}* }	**CO2**	**L2, L3**

Course Outcomes	By the end of the course, through lectures, readings, home works, assignments, andexams, students will be able to:	
	CO1	Enhance/develop ability to understand and conduct mathematical proofs for computation and algorithms.
	CO2	Design and analyze finite automata and regular expression for describing regularlanguages.
	CO3	Design and analyze pushdown automata, and context-free grammars.
	CO4	Design and analyze Turing machines.
	CO5	Enhance the ability to understand the decidability, undecidability, and reducibilitycriteria of various computational problems.
	CO6	Demonstrate the understanding of key notions, such as algorithm, computabilityand complexity through problem solving.

- ✓ *Assignment scores/markings depend on neatness and clarity.*
- ✓ *Plagiarized assignments will be given a zero mark.*
- ✓ *Submit the hard copy of your assignment by the due date, i.e.* ***09.11.2024***
- ✓ *Submit the assignment handwritten on A4 size papers and spirally bound to your ITC class teacher. A front page must be present containing the details of the subject, the assignment and the student.*