VIT®

Vellore Institute of Technology

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Reg. No. :

Final Assessment Test(FAT) - Nov/Dec 2024

Programme	**B.Tech.**	Semester	**Fall Semester 2024-25**
Course Code	**BCSE304L**	Faculty Name	**Prof. Nathezhtha T**
Course Title	**Theory of Computation**	Slot	**A1+TA1**
		Class Nbr	**CH2024250100914**
Time	**3 hours**	Max. Marks	**100**

General Instructions

- Write only Register Number in the Question Paper where space is provided (right-side at the top) & do not write any other details.

Course Outcomes

1. Compare and analyse different computational models
2. Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
3. Identify limitations of some computational models and possible methods of proving them.
4. Represent the abstract concepts mathematically with notations.

Section - I

Answer all Questions (10 × 10 Marks)

*M - Marks

Q.No	Question	*M	CO	BL
01.	Given two languages L1 and L2 over the alphabet $\Sigma = \{a, b\}$: L1 = All the strings beginning with either a or b and not having two consecutive a's (1 mark) L2 = All the strings that begin with aa and has exactly two b's (1 mark) Perform the following operations on L1 and L2 and provide the resulting language and sample strings: a. Union of two languages (2 marks) b. Concatenation of two languages (2 marks) c. Kleene Closure: L1 (2 marks) d. Positive Closure: L2 (2 marks)	10	1	2
02.	a. Design an Non-deterministic Finite Automata without ε moves over the alphabets {a, b, c, d} which accepts all the words such that either one or more letters in the word have to occur at least twice. For example, your automata must accept aba and bacdbbbab, but not abd (5 Marks) b. Design a Deterministic Finite Automata over the alphabets {x, y} which accepts all the words such that all the y's are in multiples of three and x might appear anywhere in the string like at the beginning, ending and in between the y's but in the even occurrence only permitted. Sequence of inputs will be the combination of x's and y's not like all x will be followed by y's or vice versa. For example, xxyyyxxy and xyyyx are rejected, xxyyxxy and yyxxyxxyyyxx are accepted (5 Marks)	10	1,2	3

03.	a. Convert the given Non deterministic Finite Automata N into Deterministic Finite Automata M where N = ({A,B,C,D,E,F}, { ε,0,1}, δ, A, E} and δ is defined as (5 Marks)	10	2,4	3

State / Input	ε	0	1
→ A	{B}	-	{A, D}
B	{D}	{C}	-
C	-	-	{F}
D	-	{E}	-
*E	{C, F}	-	{B}
F	-	{E}	-

b. Construct a minimized DFA M' from the above M (5 Marks)

04.	a. Build an equivalent regular expression with an intermediate steps for the given finite automata F. F = ({A, B, C}, {0, 1}, δ, A, A) where δ is defined in the table (6 marks)	10	1,2,4	3

State / Input	0	1
A	A	B
B	C	B
C	A	B

b. Let R1 and R2 are regular languages, whether the union of R1 and R2 will be a regular or not? Demonstrate with an example. (4 marks)

05.	a. In a communication device, the secret code which is made up of 0's and 1's will be shared between the persons. The code is prefixed with # and ended with $ symbol. Code must follow the below listed properties:	10	1,2,3	3

i. If the code begins with 0 then it has to ends with 0 in-between it should contain only the odd number of 1's

ii. If the code begins with 1 then every 0 has to follow a 1

iii. In either of the case, the minimum length of the code is 3

Write a regular expression for the above-mentioned device and construct an equivalent Non-deterministic Finite Automaton (NFA) with ε moves. (7 Marks)

b. Compute an epsilon closure for each state in the above constructed machine (3 Marks)

06.	Write the given context free grammar into its equivalent Greibach normal form	10	4	3

S → ABA | BA | C | AB | W

A → Aa | a

B → Bb | ε

C → AA

W → WW

07. a. Imagine there is a happy vending machine with a SCS button and a drop box. If a person stands infront of the machine it started to drop the pens. SCS button is a special button it will work only if you press it for three times. If you press the SCS button for the first time, it started to drop the jelly chocolates on the second press it started to drop slime cubes and for third press it will stop dropping slime cubes. The person can take the pens, chocolates and slime cubes if the drop box contains four jelly chocolates more than the slime cubes. Construct and define an automata for the happy vending machine to check for the condition. (7 marks) — 10 | 2,3 | 3

b. Do the instantaneous description of M for the input ((a+(a*b))*(a+a)) where M is defined as ({q0,q1,q2}, {a, b, (,)}, {(,)}, δ, q0, z0, {q2}). δ is defined as (3 marks)

δ (q0, (, z0) = (q1, (z0)

δ (q1, a, ( ) = (q1, ( )

δ (q1, b, ( ) = (q1, ( )

δ (q1, +, ( ) = (q1, ( )

δ (q1, *, ( ) = (q1, ( )

δ (q1, (, ( ) = (q1, (( )

δ (q1,), ( ) = (q1, ε)

δ (q1, ε , z0) = (q2, ε)

08. Assume you are tasked with designing a turning machine for a manufacturing process that requires determining the maximum quantity comparing two materials based on their inventory counts. The counts of these materials are represented as sequences of 0's on a tape, where the number of 0's corresponds to the quantity of each material. As input, the tape will contain two sequences of 0's separated by a delimiter C. Design a turning machine that reads the tape and finds the maximum quantity of the two materials and discuss the logic used for designing. — 10 | 2,3 | 3

Note: As a result only the maximum quantity of the two materials has to be there in an input tape. So, replace the minimum quantity with a blank symbol.

09. Jay is planning her diet: she will eat vegetables for i days, followed by fruits for j days, and then nuts for k days, where the relationship i * j = k holds true, and i, j, and k are all greater than or equal to 1. Define a language that represents this eating pattern and design a Turing machine that accepts only this specific sequence of dietary choices. — 10 | 2,3 | 3

10. a. Is the language L={(M) | M is a Turing machine that does not halt on input (M) } recursively enumerable? Justify your answer and briefly explain the implications of a language being non-recursively enumerable in the context of computability. (5 marks) — 10 | 3,4 | 2

b. Explain post correspondence problem, you are tasked with solving a problem in a combinatorial design project. There are set of dominoes, each with a string on the top and a string on the bottom. Determine if you can arrange a sequence of these dominoes such that the concatenation of the top strings matches the concatenation of the bottom strings. (5 marks)

Dominoes Available:

Index	Top String	Bottom String
1	0	01
2	01	1
3	10	0
4	1	0

BL-Bloom's Taxonomy Levels - (1.Remembering, 2.Understanding, 3.Applying, 4.Analysing, 5.Evaluating, 6.Creating)