VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

CHENNAI

Reg. No

Final Assessment Test(FAT) - Apr/May 2025

Programme	B.Tech.	Semester	Winter Semester 2024-25
Course Code	BCSE304L	Faculty Name	Prof. Sathyarajasekaran K
Course Title	Theory of Computation	Slot	D1+TD1
		Class Nbr	CH2024250501968
Time	3 hours	Max. Marks	100

Instructions To Candidates

- Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.

Course Outcomes

CO1: Compare and analyse different computational models

CO2: Apply rigorous formal mathematical methods to prove properties of languages, grammars and automata.

CO3: Identify limitations of some computational models and possible methods of proving them.

CO4: Represent the abstract concepts mathematically with notations.

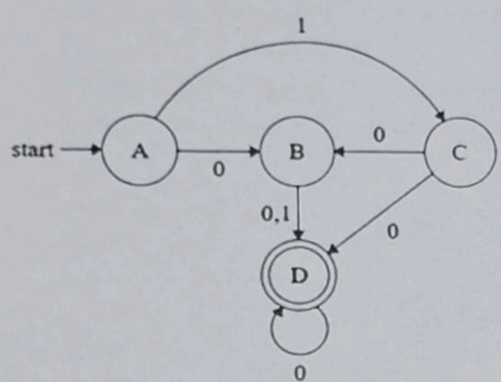
Answer all Questions (10 × 10 Marks)

01. a. Design a DFA that recognizes the numbers which give a remainder either 2 or 3 when divided by 4. Here the number is represented in binary form. (5 Marks)

b. Construct a DFA for the regular expression $(a|b)^* (a^+ |ab^+)$ (5 Marks)

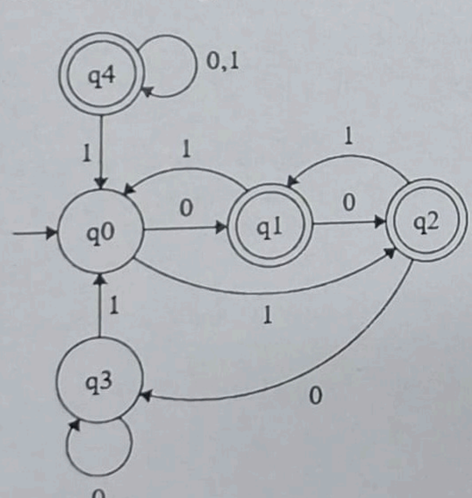
[10] (CO1/K2)

02.



a. Derive an equivalent regular expression for the above given automaton. (5 Marks)

b. For the following automaton, provide an equivalent DFA in minimized form (5 Marks)



[10] (CO2/K

03. $L_1=\{a^{2i}\, b^{j+2}\, c^k \mid i \text{ is even, } j \text{ is odd and } k>3\}$
$L_2=\{w,\ w\in\{a,b\}^*,\ |w| \text{ is divisible by } 3\}$.
$L=L_1 \mid L_2$
a. Construct the regular expression for the language L. (2 Marks)
b. Design a non-deterministic finite automaton with null moves for the constructed regular expression. (3 Marks)
c. For the constructed non-deterministic finite automata, design an equivalent deterministic finite automaton. (5 Marks)

[10] (CO2/K6)

04. $L_3=\{a^{2i+j}\, b^{2(k+1)}\, c^{3i}\, d^j \mid i>0 \text{ and even}, j\geq 0, k \text{ is odd}\}$
a. Construct a context-free grammar G_3 for the language L_3. (7 Marks)
b. Using the constructed context-free grammar, validate the following string ***aaaabbbbcccccc*** by Left Most Derivation. (3 Marks)

[10] (CO1/K4)

05. Convert the grammar G_4 given below to an equivalent grammar G_5 in Greibach Normal Form
$S\rightarrow ABC|BCD|CAF$
$A\rightarrow aA|a|\varepsilon$
$B\rightarrow BA|b|\varepsilon$
$C\rightarrow Cab|\varepsilon$
$F\rightarrow aF|bF|cF$

[10] (CO4/K3)

06. $S\rightarrow PP \mid PA \mid PB \mid PC \mid PD \mid PE \mid PF$
$P\rightarrow AB \mid CD \mid EF$
$A\rightarrow BA \mid a$
$B\rightarrow AB \mid b$
$C\rightarrow CD \mid c$
$D\rightarrow DC \mid d$
$E\rightarrow EF \mid e$
$F\rightarrow FE \mid f$
Verify whether the string ***abcdef*** is generated by the above grammar using CYK algorithm.

[10] (CO3/K3)

07. a. $L_5=\{w|w\in\{0,1\}^*$,where $|w|_0>|w|_1\}$. Verify that the given language L_5 is regular or not. (5 Marks)
b. $L_6=\{w\ |w\in\{a,b,c\}^*$, where $|w|_a<|w|_b,\ |w|_c>3\}$. Prove whether the language L_6 is a context-free language or not. (5 Marks)
Note:
$|w|_0$ number of 0's in w.
$|w|_1$ number of 1's in w
$|w|_a$ number of a's in w
$|w|_b$ number of b's in w
$|w|_c$ number of c's in w

[10] (CO1/K5)

08. $L_8=\{a^{n+2}\, b^{3n+1}\, c^m\, d^k \mid n \text{ is odd, } m \text{ is even, } k>0\}$
$L_9=\{w|w\in\{0,1\}^+$, w has an odd count of 0's and an even count of 1's$\}$
$L_7=L_8L_9$
a. Construct a deterministic pushdown automaton for the language L_7. (8 Marks)
b. Validate the string ***aaabbbbd011*** using the constructed pushdown automaton. (2 Marks)

[10] (CO4/K1)

09. $L_{10}=\{w,\ w\in\{a,b,c,d,e\}^+$, w has the arrival of symbols in the alphabetical order where the count of a is greater than count of b, count of b is greater than count of c and count of c is equal to count of d$\}$.
Construct a Turing machine for the language L_{10}.

[10] (CO4/K6)

10. a. Identify whether the lists **P = (01, 101, 11000)** and Q = **(0, 10, 101)** have a Post Correspondence Solution, where P and Q can take any position of numerator and denominator? (5 marks)
b. Discuss the Chomsky hierarchy with examples for any two languages. (5 marks)

[10] (CO3/K4)

BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)

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