REG.NO.:

SLOT: E1+TE1

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2025-2026

Programme Name & Branch	**: B.Tech. & CSE**
Course Code and Course Name	**: BCSE304L & Theory of Computation**
Faculty Name(s)	**: Common to all**
Class Number(s)	**: Common to all**
Date of Examination	**: 20/03/2026**
Exam Duration	**: 90 minutes** **Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes:
  CO1: Compare and analyse different computational models.
  CO2: Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
  CO3: Identify limitations of some computational models and possible methods of proving them.

Q. No	Question	M	CO	BL
1.	a) Construct the equivalent Finite Automaton (FA) corresponding to the given grammar by clearly specifying the set of states, input alphabet, start state, final states, and transition function. Finally, draw the state-transition diagram for the constructed automaton. $S \rightarrow aA \mid bB \mid cC \mid a$ $A \rightarrow aS \mid bD \mid cA \mid a$ $B \rightarrow bS \mid aC \mid cB \mid b$ $C \rightarrow aD \mid bA \mid cS \mid c$ $D \rightarrow aB \mid bC \mid a$	5	2	3
	b) Use the Pumping Lemma to determine whether the following language is regular or not, and show all the necessary steps to justify your conclusion. $L=\{0^m1^n2^p \mid m, n, p \geq 1 \text{ and } m+p=2n\}$	5		
2.	Consider the context-free grammar G in Chomsky Normal Form (CNF) given by the following productions: $S \rightarrow AB \mid BC \mid CD$ $A \rightarrow BA \mid a$ $B \rightarrow CC \mid b$ $C \rightarrow AB \mid AD \mid a$ $D \rightarrow BB \mid b$ Using the CYK algorithm, determine whether the following strings belong to the language generated by the grammar G: 1. **bbabb** 2. **baab** Construct the CYK parsing table for both strings and identify which string is generated by the grammar and which is not. Clearly show all intermediate computations used to conclude.	10	3	3

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3.	a) Let $L = \{ a^n b^m c^p \mid n \geq 0, m \geq 0, p \geq 0 \}$ be a language over the alphabet $\Sigma = \{a, b, c\}$. Let $h: \Sigma \rightarrow \{0,1\}^*$ be a homomorphism defined as $h(a) = 01$, $h(b) = 10$, and $h(c) = 00$. Determine the homomorphic image $h(L)$ and express the resulting language in terms of patterns over the alphabet {0, 1}. Further, analyze whether the language $h(L)$ is a regular language, and justify your answer.	5	2	4
	b) A context-free grammar may contain both null (ε) productions and unit productions. In such cases, specify the correct order in which these productions should be eliminated during grammar simplification, and justify why this order is appropriate. Then consider the following grammar and simplify it by applying the transformations in the correct order: $S \rightarrow AB \mid C$ $A \rightarrow aA \mid \varepsilon$ $B \rightarrow bB \mid A$ $C \rightarrow B \mid c$	5		
4.	Consider the following context-free grammar (CFG) G: $S \rightarrow SA \mid aB \mid b$ $A \rightarrow cA \mid d$ $B \rightarrow bB \mid c$ a). Convert the above grammar into Chomsky Normal Form (CNF) by performing the necessary transformations. b). Convert the resulting grammar (converted in 4.a) into Greibach Normal Form (GNF), and show all intermediate steps clearly.	10	3	3
5.	Give a Pushdown Automaton (PDA) that recognizes a language over the alphabet $\Sigma = \{a, b, c, d\}$ in which the strings consist of one or more **a**'s followed by **b**'s, then **c**'s, and finally **d**'s, such that the number of **b**'s is exactly twice the number of **a**'s and the number of **d**'s is exactly three times the number of **c**'s. For example, the strings abbcddd, aabbbbcddd, aaabbbbbbccdddddd belong to the language, whereas abbd, abbcdd, aabbbbcdddd, abbbbcddd do not belong to the language. a) Construct a Pushdown Automaton (PDA) that recognizes this pattern of language. b) Illustrate its operation by deriving the sequence of Instantaneous Descriptions (ID) showing the step-by-step stack configurations for the input strings **i) aabbbbccdddddd** **ii) abbbcdddd**	10	1	3

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