PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

Department of Applied Mathematics and Computational Sciences

MSc - Theoretical Computer Science - Semester 5

CONTINUOUS ASSESSMENT TEST 2

23XT51 - Theory of Computing

Date: 28.10.2025

Time: 1 Hour 30 min. **Maximum Marks: 40**

INSTRUCTIONS
1. Answer **ALL** questions. Each question carries 20 Marks.
2. Subdivisions (a)(i) and (a)(ii) carry 2 marks each, subdivision (b) carries 6 marks, and subdivision (c) carries 10 marks.
3. Course Outcome Table: Qn. 1 | CO - 3 ; Qn. 2 | CO - 4

Qn.1

(a) (i) When do we call a grammar ambiguous? Which one is more efficient: brute-force parsing or the CYK algorithm? **(BTL-2)**

(ii) Consider the following grammar.

$$\begin{aligned} S &\rightarrow 0A|1B \\ A &\rightarrow 0AA|1S|1 \\ B &\rightarrow 1BB|0S|0 \end{aligned}$$

Find the leftmost derivation and the rightmost derivation for the string $w = 001011$. **(BTL-3)**

(b) Draw a derivation tree for the word *aabbcccddd* from the following grammar

$$\begin{aligned} S &\rightarrow AB|C \\ A &\rightarrow aAb|ab \\ B &\rightarrow cBd|cd \\ C &\rightarrow aCd|aDd \\ D &\rightarrow bDc|bc \end{aligned}$$

Is the grammar ambiguous? If yes, can you find an equivalent unambiguous grammar? **(BTL-4)**

(c) Detail the steps to convert CFG into CNF. Apply it to the following CFG.

$$G\text{: } S \rightarrow aXbX,\ X \rightarrow aY|bY|\lambda,\ Y \rightarrow X|c$$

Also, use the CYK algorithm to determine whether the string *aabcbc* is in the language generated by G. **(BTL-3)**

Qn.2

(a) (i) State True or False:

1. Given a CFG G, is $L(G) = \emptyset$ decidable? T
2. Let $L_1 = \bigcup_{i=0}^{\infty} \{a^n b^i c \ : \ n \geq 0\}$ and $L_2 = \{a^n b^n c^n \ : \ n \geq 0\}$. Then, $L_1 \cap L_2$ is a CFL. T
3. If L is a DCFL, then $\overline{L}$ is not necessarily a CFL. F
4. The memory of a DPDA is unbounded. T

(BTL-2)

(ii) Explain the difference between DPDA and NPDA. Describe how DPDA differs from DFA.

(BTL-2)

(b) State the pumping lemma for CFG. Show that the language $L = \{ww^R w \ : \ w \in \{a, b\}^*\}$ is not context-free.

(BTL-5)

(c) Define a PDA and the language accepted by a PDA. Design a PDA that accepts the language $\{a^n b^m c^m d^n \ : n, m \geq 0\}$ by final state. Test your PDA with the strings *aabbccdd* and *aaabcdd*.

(BTL-6)