

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
Theory of Computation (CS1143)
End Term, B.Tech., VI Semester

Dated: 07th May 2025

Time: 3 hr

MM: 40

Name: _____ Roll No.: _____

Attempt all questions.

1. Determine if the following post-correspondence problem (PCP) instance has a sol. (CS1143:5, 3 marks)

A.

Index	A	B
1	10	101
2	011	11
3	101	011

B.

Index	W	X
1	aab	aba
2	bb	bba
3	aaaa	b

2. Verify the following language.

(CS1143:3,4, 2+2.5*2 marks)

- A. $L_1 = \{a^m b^n c^n d^m \mid m, n \geq 1\}$ be a C.F.L
 B. $L_2 = \{ww \mid w \in \{0, 1\}^*\}$ be a non-C.F.L
 C. The process of converting a unary string to its binary equivalent via a Turing machine to be a recursively enumerable language.

3. Discuss the following statement.

(CS1143:4, 2+2 marks)

- A. K-tape Turing Machine $\equiv$ 1-tape Turing Machine
 B. The computation process of a Universal Turing Machine (U.T.M). Is the language accepted by a U.T.M. recursively enumerable?

4. Encode the given Turing machine in its binary form, based on the transition function

$$\delta(q_i, x_j) = (q_k, x_l, m),$$

where q_i, q_j are states, 0, 1, b are tape symbols, and $m \in \{L, R\}$ is the direction of the head.

State	0	1	b
q_1	$(q_2, 1, R)$	$(q_2, 0, L)$	—
q_2	$(q_3, 1, L)$	$(q_3, 0, R)$	—
q_3	$(q_4, 1, L)$	$(q_4, 1, L)$	$(q_4, 1, R)$
q_4	$(q_2, 0, L)$	$(q_5, 1, R)$	$(q_2, 1, L)$
q_5	—	—	—

(CS1143:4, 2 marks)

5. Define the following classes of computational complexity:

- A. P class
- B. NP class

(CS1143:5, 2 marks)

6. Prove or Disprove

- A. The language

$$A_{TM} = \{ \langle M, w \rangle \mid \text{Turing machine } M \text{ accepts input } w \}$$

is undecidable, where $\langle M, w \rangle$ denotes the encoding of a Turing machine M and an input string w .

- B. The class of C.F.L is closed under intersection.

(CS1143:4,5, 3+2 marks)

7. Discuss the computation process of a Pushdown Automaton (PDA). Then, construct a PDA for the language

$$L = \{ w \in \{a, b\}^* \mid w = \text{rev}(w) \}$$

where $\text{rev}(w)$ denotes the reverse of the string w .

(CS1143:3, 3 marks)

8. Justify the equivalence between the class of languages accepted by Pushdown Automata (PDA) and the class of Context-Free Languages (CFLs). Illustrate your justification with a suitable example.

(CS1143:3, 3 marks)

9. Construct a Deterministic Pushdown Automaton (DPDA) for the language

$$L = \{ w c w^R \mid w \in \{0, 1\}^* \}$$

where w^R denotes the reverse of the string w , and c is a constant symbol.

(CS1143:3, 3 marks)

10. Answer the following questions related to regular languages:

- A. If L is a regular language, then L^R (the reversal of L) is also a regular language. Justify your answer.
- B. The intersection of two regular languages is also a regular language. Provide a brief explanation or supporting construction.
- C. Let $L = \{ w \in \{0, 1\}^* \mid w \text{ does not contain } 101 \text{ as a substring} \}$.
 - Is L a regular language?
 - Identify the dump state(s) in a DFA for L .
 - Determine whether the strings "0110" and "101" are accepted by L .

(CS1143:1,2, 3+2+3 marks)