JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

B.Tech-III Semester (CSE)

COURSE CODE (CREDITS):25B11CI315 (3) MAX. MARKS: 25

COURSE NAME: Theory of Computation

COURSE INSTRUCTORS: ARV*, MNK, NSA, RMS, SKS, SMA MAX. TIME: 1 Hour 30 Min

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

Q. No	Question	CO	Marks
Q1	Consider the following PDA Machine M = ({q0, q1}, {0,1}, {X, Zo}, δ, q0, Zo, {}) with the transitions given by δ(delta): δ (q0,0, Z0) = (q0, XZo) δ (q0,0, X) = (q0, XX) δ (q0,1, X) = (q1, ε) δ (q1,1, X) = (q1, ε) δ (q1, e, X) = (q1, ε) δ (q1, e, Zo) = (q1, ε)	4	5
Q2	Convert the following context-free grammar to an equivalent PDA. Write the terminals, non-terminals, and all final transitions. S→aaB | Abb| ε A→a | aA B→b | bB	4	5
Q3	(a) Consider the following four languages over the alphabet Σ = {a, b, c}: $L_1 = \{a^i b^j c^k \mid j = j \text{ or } j = k, \text{ where } i, j, k \geq 0\}$ $L_2 = \{a^i b^j c^k \mid i = j \text{ and } j = k, \text{ where } i, j, k \geq 0\}$ $L_3 = \{a^i b^j c^k \mid i < j < k, \text{ where } i, j, k \geq 0\}$ $L_4 = \{a^n b^n c^k \mid n, k \geq 0\}$ Identify which of these languages is a Deterministic Context-Free Language (DCFL). Justify your answer briefly by explaining why the other three are not DCFLs.	4	[4+3+3]

	(b) For the language you identified as a DCFL in Part a, design a Deterministic Pushdown Automaton (DPDA) that recognizes it. • Provide a formal definition of your DPDA as a 7-tuple ($Q, \Sigma, \Gamma, \delta, q_0, Z_0, F$). • Clearly describe the meaning of each state in Q. • Draw a clear state diagram for the DPDA. (c) Identify whether the given language is Recursive, Recursively Enumerable but Not Recursive or Not Recursively Enumerable language and justify your answer. $L = \{a^p \mid p \text{ is a prime number}\}$		
Q4	Design a Turing machine that accepts the language $L = \{a^n b^m a^n : m > n\}$	5	5
Q5	Consider the simple (regular, in fact) language $L = \{w \varepsilon \{0,1\}^* : \lvert w\rvert \text{ is odd}\}$ **(a)** Provide a Turing machine that decides L. **(b)** Provide a Turing machine that semi decides L.	5	5
Q6	Match the Following:	5	5

Column A	**Column B**
A. Decision Problem	1.Ambiguity Problem for CFGs
B. Halting Problem	2. Ask "Yes/No" questions
c. Undecidable	3. Classic undecidable problem
D. Contradiction	4. Output required to be both halting and non-halting under same assumption.
E P vs NP	5. Concerned with complexity classification