AHMEDABAD UNIVERSITY
School of Engineering and Applied Science
2025-2026 Monsoon

CSE525/CSE406 Theory of Computing
End-Term Examination
Tuesday 02 December 2025. 11:00 - 12:30

Name:	Roll no.	A	U	2						Marks ----/30

- *Unnecessarily lengthy solutions will be penalized.*
- *If you need to make any assumptions, state them clearly.*
- *Results/Proofs covered in class may simply be cited (if required).*
- *If none of the answers are correct, simply write the correct answer.*

1. Nobody knows yet if $P = NP$. Consider the language L defined as follows

$$L = \begin{cases} (0+1)^* & \text{if } P = NP \\ \phi & \text{otherwise.} \end{cases}$$

Now consider the following statement: "L is undecidable". Logically argue the correctness of this statement. [4]

2. Consider the following types of languages – L_1: Regular, L_2: Context-free, L_3: Recursive, L_4: Recursively enumerable. Note that, the complement of context-free language is context-sensitive. Now, identify the following languages: [4] **(Also give the explanation, why?)**

(a) $\overline{L_3} \cup L_4 =$
Why?

(b) $\overline{L_2} \cup L_3 =$
Why?

(c) $L_1^* \cap L_2 =$
Why?

(d) $L_1 \cup \overline{L_2} =$
Why?

3. Consider the language L over $\{a, b\}$ which contains the string whose length are form the arithmetic progression $P = \{2, 5, 8, 11, \cdots\}$. Design a minimum DFA for the language L. [4]

4. Prove or disprove that L is decidable if and only if L and $\overline{L}$ are Turing recognizable. [4]

5. Let X be a recursive language and Y be a recursively enumerable but not recursive language. Let W and Z be two languages such that $\overline{Y}$ reduces to W, and Z reduces to $\overline{X}$ (reduction means the standard many-one reduction). What can we say (class) about the language of W and Z (Explain, why)? [2]

6. Consider the following language $A = \{\langle D \rangle | D \text{ is a DFA } \& \ L(D) = \phi\}$. Construct a holting Turing Machine for the language L (if possible). [2]

7. Consider the following DFA with $Q = \{q_1, q_2, q_3, q_4\}, \Sigma = \{a, b\}$, where the state and final state is q_1. Following is the transitions: $(q_1, a) \rightarrow q_2$, $(q_1, b) \rightarrow q_3$, $(q_2, a) \rightarrow q_4$, $(q_2, b) \rightarrow q_1$, $(q_3, a) \rightarrow q_1$, $(q_3, b) \rightarrow q_4$, $(q_4, a) \rightarrow q_4$, $(q_4, b) \rightarrow q_4$. Compute the regular expression recognized by the DFA Q [3].

8. (3 marks)

8.(a) Consider the following context-free grammar over the alphabet $\Sigma = \{a, b, c\}$ with S is the start symbol, $S \rightarrow abScT|abcT, T \rightarrow bT|b$. Identify the corresponding language generated by the above grammar?

8.(b) Following language $L = \{a^m b^n c^p d^q | m + p = n + q$, where $m, n, p, q \geq 0\}$, is context-free or not? If not-context free, explain why it requires two stack; otherwise, explain push and pop operations for alphabets a, b, c, d.

9. Construct a minimum DFA for the language $L = \{w \in \{0,1\}^* | w$ contains at least two 0's & at most one 1 $\}$. [3]

10. Consider the following statement (Church-Turing Thesis) "Anything that can be computed can be computed by a Turing Machine". What is the possible most important implication of this statement? (Write at most 2 sentences). [1]

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Part A

1. A TM can be represented using a finite string consisting of symbols from some finite alphabet (i.e., can be converted to a binary string). Following this, to every natural number we can associated a TM. If a number does not map to a TM by the earlier representation then we map it to the TM that accepts all input. Now, let M_j denotes the j-th TM and S_j be the j-th binary string. Next, prove or disprove that the language $L_d = \{S_j | S_j \notin L(M_j)\}$ is a non-Turing recognizable language. [Marks 10]

2. Design a TM with $\Sigma = \{a, b\}$ which accepts all strings with equal number of a and b. [Marks 10]

3. Prove or disprove (following Pumping Lemma) that L = $\{0^n 1^n 2^n | n \geq 0\}$ is not context-free. [Marks 10]