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Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Automata Theory and Computability

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Define the following with example: i) Alphabet ii) Power of an alphabet iii) String and length of string iv) Concatenation v) Language. (10 Marks)
- b. Define DFSM. Design a DFSM to accept each of the following languages:
 $L = \{W : |W| \bmod 3 = 0\}$ where $\Sigma = \{a\}$
 $L = \{W \in \{a, b\}^* : W \text{ Ending with } abb\}$ (10 Marks)

OR

- 2 a. Define NDFSM. Design an NFA to recognize the following set of string : [0101, 101, 011]. (06 Marks)
- b. Design an NFA to obtain string of a and b ending with ab (or) ba, convert it into its equivalent DFA. (08 Marks)
- c. Differentiate between DFA, NFA and ϵ NFA. (06 Marks)

Module-2

- 3 a. Define regular expression, write the regular expression for the following languages:
 i) $\{W \in \{0, 1\}^* : |W| \text{ is even}\}$
 ii) $\{W \in \{0, 1\}^* : \text{has } 001 \text{ as substring}\}$
 iii) $\{W \in \{a, b\}^* : \text{whose second symbol from right end is } a\}$
 iv) $\{W \in \{a, b\}^* : \text{starting with 'a' and ending with } b\}$ (06 Marks)
- b. Show that every regular expression there is an equivalent FSM. (06 Marks)
- c. Construct FSM for the regular expression
 i) $a^* + b^* + c^*$ ii) $(a + b)^* aa (a + b)^*$ (08 Marks)

OR

- 4 a. State and prove pumping lemma theorem for RL and ST the language $L = \{a^i b^j : i, j \geq 0 \text{ and } i - j = 5\}$ is not regular. (12 Marks)
- b. List the closure properties of regular language. Explain any two of them with example. (08 Marks)

Module-3

- 5 a. Define context free grammar. Design CFG for the following languages:
 i) Let $\Sigma = \{a, b\}$ to generate string of even number of a's.
 ii) $L = \{a^n \cdot b^n : n \geq 0\}$
 iii) To generate string consisting of multiples of three a's. (10 Marks)
- b. Obtain the grammar to generate the following language:
 i) $L = \{0^m 1^n 2^n : m \geq 1 \text{ and } n \geq 0\}$
 ii) $L = \{a^i b^j : i \neq j, i \geq 0 \text{ and } j \geq 0\}$ (10 Marks)

OR

- 6 a. What is ambiguity? Show that the following grammar is ambiguous
 $S \rightarrow AB \mid aaB$
 $A \rightarrow a \mid Aa$
 $B \rightarrow b$ (06 Marks)
- b. Define push down automata. Obtain a PDA to accept the language $L = A^n B^n = \{a^n b^n : n \geq 1\}$ (08 Marks)
- c. i) Derive leftmost derivation for the string aaabbabbba using the following grammar
 $S \rightarrow aB \mid bA$
 $A \rightarrow aS \mid bAA \mid a$
 $B \rightarrow bS \mid aBB \mid b$
 ii) Obtain the rightmost derivation for the string $id + id * id$ using
 $E \rightarrow E + E$
 $E \rightarrow E * E$
 $E \rightarrow E - E$
 $E \rightarrow E/E$
 $E \rightarrow id$ (06 Marks)

Module-4

- 7 a. Define Turing machine model. Explain representation of Turing machine. (08 Marks)
- b. Design a Turing machine to accept $L = \{0^n 1^n 2^n \mid n \geq 1\}$ (08 Marks)
- c. Write a short note on multi tape TM. (04 Marks)

OR

- 8 a. With neat diagram, explain variants of TM. (10 Marks)
- b. Explain the model of linear bound automation. (05 Marks)
- c. Explain the working of a Turing machine. (05 Marks)

Module-5

- 9 a. Explain the following with example:
 i) Decidability
 ii) Decidable language
 iii) Undecidable language. (06 Marks)
- b. Explain post correspondence problem. (07 Marks)
- c. Explain halting problem in TM. (07 Marks)

OR

- 10 Write a short note on:
 a. Growth rate of function
 b. Classes of P and NP
 c. Quantum computers
 d. Church-Turing thesis. (20 Marks)
