CBCS SCHEME

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18CS54

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) Concatination v) Language. **(10 Marks)**

b. Define DFSM. Design a DFSM to accept each of the following languages:

$L = \{W : |W| \bmod 3 = 0\}$ where $\Sigma = \{a\}$

$L = \{W \in \{a, b\} : W$ 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 $\in$NFA. **(06 Marks)**

Module-2

3 a. Define regular expression, write the regular expression for the following languages:

i) $\{W \in \{0,1\}^* \ |W|$ is even$\}$

ii) $\{W \in \{0,1\}^*$ has 001 as substring

iii) $\{W \in \{a,b\}^*$ whose second symbol from right end is a$\}$

iv) $\{W \in \{a,b\}^*$ 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 $L = \{a^i b^j : i, j \geq 0$ 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 grammer. 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 grammer to generate the following language:

i) $L = \{0^m 1^m 2^n | m \geq 1$ and $n \geq 0\}$

ii) $L = \{a^i b^j | i \neq j, i \geq 0$ 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 $L = A^nB^n = \{a^nb^n : n \geq 1\}$ **(08 Marks)**

c. i) Derive leftmost derivation for the string aaabbabbba using the following grammer
$S \rightarrow aB \mid bA$
$A \rightarrow aS \mid bAA \mid a$
$B \rightarrow bS \mid aBB \mid b$
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)**

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