

Exam Date & Time: 26-Jun-2024 (02:30 PM - 05:30 PM)



MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH. DEGREE EXAMINATIONS - JUNE 2024

SUBJECT: CSE 2221/CSE_2221 - FORMAL LANGUAGES AND AUTOMATA THEORY
(COMPUTER SCIENCE AND ENGINEERING - ARTIFICIAL INTELLIGENCE AND MACHINE
LEARNING / COMPUTER SCIENCE / COMPUTER SCIENCE AND ENGINEERING - CYBER
SECURITY)

FORMAL LANGUAGES AND AUTOMATA THEORY [CSE 2221]

Marks: 50

Duration: 180 mins.

A

Answer all the questions.

- 1A) Transform the given Languages into equivalent Grammars
 i) $L = \{ a^n b^{n+2} \mid n \geq 0 \}$ with only one variable and $\Sigma = \{a, b\}$
 ii) $L = \{ a^{3n} b^n \mid n \geq 1 \}$ with exactly 1 variable and $\Sigma = \{a, b\}$ (3)
 iii) $L = \{ a^m b^n \mid m \geq n, n \geq 0 \}$ with exactly 2 variables $\Sigma = \{a, b\}$
- 1B) i) Construct a DFA with exactly 3 states, which accepts set of all strings with over $\Sigma = \{a, b\}$ such that second symbol from RHS is 'a'.
 ii) Construct a DFA which accepts set of all strings with (3)
 $L = \{ a^n \mid n \geq 1, n \neq 3 \}$ with $\Sigma = \{a\}$
- 1C) Construct a NPDA for accepting the language $L = \{ a^n b^m c^n \mid m, n \geq 1 \}$
 Explain the logic used in constructing the NPDA. Give the instantaneous representation (4)
 of the NPDA
- 2A) Describe the seven-tuple definition of a Turing Machine. What is a Non-deterministic Turing Machine? (2)
- 2B) i) Discuss the RE for the languages over $\Sigma = \{a, b\}$
 $\{ w \in \Sigma^* \mid w \text{ contains exactly one double letter} \}$ (4)
 ii) Draw a NFA for the RE $(a+ba^*)a^*$
- 2C) i) Formally define a regular grammar that generates the language on $\Sigma = \{x, y\}$ consisting of all strings with no more than three y's.
 ii) Construct a NFA N from the grammar $G = (\{S, T, U\}, \{a, b\}, S, P)$, where P is: $S \rightarrow a$ (4)
 $| b | aT | aU | bT | bU, T \rightarrow a, U \rightarrow b$
- 3A) i) Convert the given CFG to Greibach Normal Form. (4)
 $S \rightarrow aA | aBB$
 $A \rightarrow aAA | \lambda$
 $B \rightarrow bB | bbC$
 $C \rightarrow B$
 ii) Let G be $S \rightarrow aS | Sa | a$. Show that L is ambiguous. Can there be an unambiguous

grammar for G?

- 3B) Remove useless productions from the grammar.
 $S \rightarrow aaA \mid Bb \mid C$
 $A \rightarrow bB \mid AB \mid aA \mid \lambda$
 $B \rightarrow bb \mid A \mid \lambda$
 $C \rightarrow b \mid Bb$ (3)

- 3C) Find S grammar for the regular expression (aaa^*b+b) (3)

- 4A) Prove that the language $L = \{a^n: n \text{ is a prime number}\}$ is not context-free using Pumping Lemma. (3)

- 4B) Let a CFG with the following production rules.

$S \rightarrow aA$
 $A \rightarrow aABC \mid bB \mid a$
 $B \rightarrow b$
 $C \rightarrow c$ (3)

Using CFG to PDA conversion procedure, obtain the corresponding PDA with a transition diagram for the above CFG. Test whether "aaabc" is acceptable by this PDA.

- 4C) Design a Turing Machine with a transition diagram to accept a string w of 0's and 1's such that the number of 0's in w is equal to number of 1's in w . Show that the Turing machine accepts some valid input. (4)

- 5A) Let two positive integers A and B represented in unary. With a transition diagram design a Turing Machine which will replace the separator "0" with a "1" and the other current tape contents with "Blank" symbols, if $A > B$. Write instantaneous description (ID) for the string "1111011". (4)

- 5B) Explain the defining properties of context-sensitive grammars and discuss their role in the Chomsky hierarchy of formal languages. (3)

- 5C) Discuss the significance of the Post Correspondence Problem (PCP) in the context of algorithmic computation. With an example show that the Post correspondence problem is undecidable. (3)

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