

# Question Paper

Exam Date & Time: 09-May-2024 (02:30 PM - 05:30 PM)



## MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH. DEGREE EXAMINATIONS - APRIL / MAY 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)

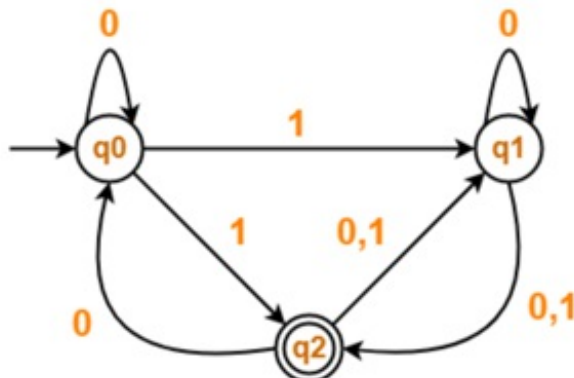
Marks: 50

Duration: 180 mins.

Answer all the questions.

1A) Design a DFA with a transition diagram to accept the following language, (3)  
 $L = \{ab^4wb^2 : w \in \{a, b\}^*\}.$

1B) Construct the equivalent DFA for the following NFA (3)



1C) Design a PDA with a transition diagram to accept the following language, (4)  
 $L = \{a^i b^j c^k \mid i, j, k \geq 0, i=j \text{ or } j=k\}.$

Show whether the obtained PDA is deterministic or non-deterministic.

2A) Describe with a diagram the Standard Turing Machine. Then show the situations of the tape before (2)  
and after the move  $\delta(q_0, a) = (q_1, d, R)$

2B) i) Describe the RE for the languages over  $\Sigma = \{a, b\}$  (4)  
a.  $\{w \in \Sigma^* \mid w \text{ has exactly one pair of consecutive } a\}$   
b.  $\{w \in \Sigma^* \mid w \text{ does not end with a pair of consecutive letter}\}$

ii) Draw a NFA for the RE  $((aa)^* + bb^*)^*$

2C) i) Construct an automaton that accepts the language generated by the grammar. (4)  
 $S \rightarrow abA$   
 $A \rightarrow baB$   
 $B \rightarrow aA \mid bb$

ii) Check whether the given grammar is ambiguous or not by using parse trees for the generation of the string aabbccdd

$S \rightarrow AB / C$   
 $A \rightarrow aAb / ab$   
 $B \rightarrow cBd / cd$   
 $C \rightarrow aCd / aDd$   
 $D \rightarrow bDc / bc$

- 3A) Consider the grammar G whose productions are: (3)  
 $S \rightarrow aAS \mid A$   
 $A \rightarrow SbA \mid SS \mid ba$   
 Show that  $S \Rightarrow^* aabbba$  and construct a derivation tree whose yield is aabbba.
- 3B) Find a grammar in CNF that is equivalent to the following grammar (The only variable here is S): (3)  
 $S \rightarrow \sim S \mid [S \supset ] \mid p \mid q$
- 3C) Design a PDA for accepting a language  $\{a^n b^{2n} \mid n \geq 1\}$  with a transition diagram. Specify the corresponding 7 tuple specification. (4)
- 4A) Find the S grammar to generate the language  $L = \{a^n b^n \mid n \geq 1\}$  (3)
- 4B) Show that the language  $L = \{ww : w \in \{a,b\}^*\}$  is not context free using pumping lemma. (3)
- 4C) Design a Turing Machine using transition function to accept a language  $L = \{a^n b^m : n < m\}$  (4)  
 where the tape will have a, and b as the only input symbols.
- 5A) Design a transducer with 5 states using transition diagram to generate  $ww^R$  from w, where  $w \in \{a,b\}^+$ . Show the computation of the string ab in the transducer, which after processing will contain abba. (4)
- 5B) Discuss the automata, grammar, and the associated languages with appropriate examples at each level of the Chomsky Hierarchy. (3)
- 5C) Elaborate on the Enumeration procedure with reference to universal Turing Machine. Discuss the relationship between enumeration procedures and Turing machines with respect to countability (3)

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