

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B.Tech

SEM: IV - THEORY EXAMINATION (2021 - 2022)
Subject: Theory of Automata and Formal Languages

Time: 3 Hours

Max. Marks: 100

General Instructions:

1. The question paper comprises three sections, A, B, and C. You are expected to answer them as directed.
2. Section A - Question No- 1 is 1 mark each & Question No- 2 carries 2 mark each.
3. Section B - Question No-3 is based on external choice carrying 6 marks each.
4. Section C - Questions No. 4-8 are within unit choice questions carrying 10 marks each.
5. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION A

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1. Attempt all parts:-

1-a. A Language for which no DFA exist is a _____ (CO1)

- (a) Regular Language
- (b) Non-Regular Language
- (c) May be Regular
- (d) Cannot be said

1-b. Which of the following option (Statement) is correct? (CO1)

- (a) NFA is slower to process and its representation uses more memory than DFA
- (b) DFA is faster to process and its representation uses less memory than NFA
- (c) NFA is slower to process and its representation uses less memory than DFA
- (d) DFA is slower to process and its representation uses less memory than NFA

1-c. Every regular grammar is _____ (CO2)

- (a) context free grammar
- (b) non context free grammar
- (c) english grammar
- (d) none of the mentioned

1-d. $(a+b)^*$ is equivalent to _____ (CO2)

- (a) b^*a^*
- (b) $(a^*b^*)^*$
- (c) a^*b^*
- (d) none of the mentioned

1-e. Context free languages are _____ (CO3)

- (a) Closed under union
- (b) Closed under complementation
- (c) Closed under intersection
- (d) Not closed under union

1-f. Give a production grammar that accepts the specified language $L = \{a^i b^{2i} \mid i \geq 1\}$ (CO3)

- (a) $\{S \rightarrow aSbb, S \rightarrow abb\}$
- (b) $\{S \rightarrow aSb, S \rightarrow b\}$
- (c) $\{S \rightarrow aA, S \rightarrow b, A \rightarrow b\}$
- (d) None of these

1-g. Which Automata takes stack as storage? (CO4)

- (a) Finite Automata
- (b) Push Down Automata
- (c) Turing Machine
- (d) Regular Expression

1-h A language accepted by Deterministic Push down automata is closed under which of the following? (CO4) 1

- (a) Complement
- (b) Union
- (c) All of the mentioned
- (d) None of the mentioned

1-i If Turing machine accepts all the words of the language L and rejects or loops for other words, which are not in L, then L is said to be ____ (CO5) 1

- (a) recursively enumerable
- (b) recursive
- (c) context free language (cfl)
- (d) none of them

1-j Which of the following problems is undecidable? (CO5) 1

- (a) Finiteness problem for FSAs
- (b) Membership problem for CFGs
- (c) Equivalence problem for FSAs
- (d) Ambiguity problem for CFGs

2. Attempt all parts:-

- 2.a. How will you find the Reverse of a regular language? Explain. (CO1) 2
- 2.b. Define alphabet, language and strings. (CO2) 2
- 2.c. Eliminate the Unit productions from the following Grammar:
 $S \rightarrow XY \mid a, X \rightarrow Y, Y \rightarrow Z \mid b, Z \rightarrow c$ (CO3) 2
- 2.d. List any two languages that can be implemented by both DFA and PDA. (CO4) 2
- 2.e. State halting problem of Turing Machine. (CO5) 2

SECTION B

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3. Answer any five of the following:-

- 3-a Construct a finite automaton (deterministic or nondeterministic) that recognizes the language over the alphabet $\{a, b, c\}$ of all strings not containing the substring ba (CO1) 6
- 3-b Construct a Mealy Machine that accepts all the strings ending in 01 and 11 over an alphabet $\Sigma = \{0, 1\}$. Convert the same to a Moore Machine. (CO1) 6
 Construct a Mealy Machine that accept string ending in 01 and 11. Convert the same to a Moore Machine.
- 3-c. Explain Left Linear Grammar and Right Linear Grammar with the help of suitable examples. (CO2) 6
- 3-d. Describe and prove any 3 closure properties of regular languages (with example). (CO2) 6
- 3.e. Show that the Grammar with rule $E \rightarrow E - E \mid E + E \mid E * E \mid E \wedge E \mid a$ is ambiguous. Also rewrite an Unambiguous Grammar for the same. (CO3) 6
- 3.f. Construct a DPDA which accepts the following language, (CO4) 6
 $L = \{wcw^R \mid w \in \{a, b\}^*, \Sigma = \{a, b, c\}\}$
- 3.g. Write short notes on : (1) Linear Bounded Automata (2) Universal Turing machine (CO5) 6

SECTION C

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4. Answer any one of the following:-

3-a

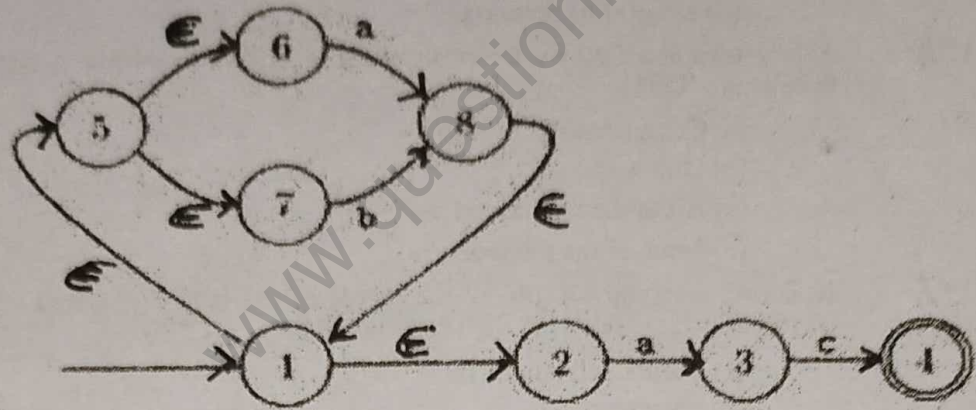
Draw an NFA that accepts a language L over an input alphabet $\Sigma = \{a, b\}$ such that L is the set of all strings where 3rd symbol from the right end is 'b'. Also convert the same to DFA. (CO1)

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4-b

Convert the following NFA- ϵ into NFA without ϵ . (CO1)

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5. Answer any one of the following:-

5-a

State Pumping Lemma for Non-Regular languages. Prove that the language $L = \{a^n b^n \mid n \geq 0\}$ is not regular. (CO2)

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5-b

Write regular expression for the following Languages over $\Sigma = \{x, y\}$ that contains: (CO2)

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- (i) Strings where number of x's are even
- (ii) Strings with length at least 5.
- (iii) Strings where 4th symbol from the end is y.
- (iv) Strings where there are no two consecutive x's.
- (v) Strings with length at most two.

6. Answer any one of the following:-

6-a.

Write the steps to convert CFG to GNF. (CO3)

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6-b.

State the pumping lemma for context free languages. Show that the language, $L = \{0^n 1^n 2^n \mid n \geq 0\}$ is not a context free language. (CO3)

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7. Answer any one of the following:-

7-a

Compare Deterministic and Non deterministic PDA. Is it true that non deterministic PDA is more powerful than deterministic PDA? Justify your answer. (CO4)

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7-b

Compare FM and PDA. Construct a PDA accepting all palindromes over $\{a, b\}$. (CO4)

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8. Answer any one of the following:-

8-a.

Show that the union of two recursively enumerable languages is also a recursively enumerable language and union of two recursive languages is recursive. (CO5)

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8-b.

Define turing machine and describe its capabilities.

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Construct a TM for the language: $L = \{a^n b^n c^n \mid n \geq 0\}$ (CO5)