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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - THEORY EXAMINATION (2023 -2024)

Subject: Theory of Automata and Formal Languages

Time: 3 Hours

Max. Marks: 100

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of **three Sections -A, B, & C**. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.
2. Maximum marks for each question are indicated on right -hand side of each question.
3. Illustrate your answers with neat sketches wherever necessary.
4. Assume suitable data if necessary.
5. Preferably, write the answers in sequential order.
6. 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 regular language over an alphabet Σ is one that cannot be obtained from the basic languages using the operation. (CO1) 1
- (a) Union
 - (b) Concatenation
 - (c) Kleene*
 - (d) All of the mentioned
- 1-b. Under which of the following operation, NFA is not closed? (CO1) 1
- (a) Negation
 - (b) Kleene
 - (c) Concatenation
 - (d) None of the mentioned
- 1-c. A language is regular if and only if (CO2) 1
- (a) accepted by DFA
 - (b) accepted by PDA
 - (c) accepted by LBA
 - (d) accepted by Turing machine
- 1-d. Find the regular expression for language $L = \{\text{set of strings of a's and b's end with a}\}$. (CO2) 1
- (a) $(a+b)^* a$

- (b) $a(a+b)^*b$
- (c) $(a^*b^*)^*a$
- (d) Both option A and C
- 1-e. A grammar that produce more than one parse tree for same sentence is called : 1
(CO3)
- (a) Ambiguous
- (b) Unambiguous
- (c) Regular
- (d) None
- 1-f. Push down automata accepts _____ languages. (CO3) 1
- (a) Type 3
- (b) Type 2
- (c) Type 1
- (d) Type 0
- 1-g. Context Sensitive Grammar can be recognized by : (CO4) 1
- (a) Deterministic Pushdown Automata
- (b) Non- Deterministic Pushdown Automata
- (c) Finite State Machine
- (d) Linear Bound Automata
- 1-h. A non deterministic pushdown acceptor is defined by _____ tuples (CO4) 1
- (a) 5
- (b) 6
- (c) 8
- (d) 7
- 1-i. 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
- 1-j. The language recognized by Turing machine is: (CO5) 1
- (a) Context free language
- (b) Context sensitive language
- (c) Recursively enumerable language
- (d) Regular language
2. Attempt all parts:-
- 2.a. Construct a DFA for language over $\Sigma = \{a, b\}$ where every strings ends with ab. (CO1) 2
- 2.b. Write application of pumping lemma for regular languages. (CO2) 2

- 2.c. Discuss the procedure to eliminate useless symbol from a Context Free Grammar. (CO3) 2
- 2.d. Differentiate between DPDA and NPDA. (CO4) 2
- 2.e. Explain Universal Turing Machine. (CO5) 2

SECTION-B

30

3. Answer any five of the following:-

- 3-a. Design Finite Automata which accepts the language $L = \{w \in (0,1)^* \mid \text{second symbol of } w \text{ is } 0 \text{ and fourth input is } 1\}$. (CO1) 6
- 3-b. Design a DFA to accept string of 0's & 1's when interpreted as binary numbers would be multiple of 3. (CO1) 6
- 3-c. Explain Left Linear Grammar and Right Linear Grammar with the help of suitable examples. (CO2) 6
- 3-d. Draw NFA with epsilon transition for the R.E. $a^*(a+b)^*(ab^*a)^*$. (CO2) 6
- 3.e. Write the procedure and Eliminate left recursion from the following Grammar (CO3) 6
- $E \rightarrow E + T / T$
 $T \rightarrow T * F / F$
 $F \rightarrow (E) / id$
- 3.f. Design a PDA for the language $L = \{w c w^r \mid w \in \{a, b\}^*\}$. (CO4) 6
- 3.g. Define Recursive language and Recursively enumerable languages? (CO5) 6

SECTION-C

50

4. Answer any one of the following:-

- 4-a. Define moore and melay machine Construct a Moore machine that determines whether an input string contains an even or odd number of 1's. The machine should give 1 as output if an even number of 1's are in the string and 0 otherwise. (CO1) 10
- 4-b. Explain Chomsky Classification of Grammars in detail. (CO1) 10

5. Answer any one of the following:-

- 5-a. Write regular expression for the following Languages over $\Sigma = \{x, y\}$ that contains: (CO2) 10
- (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.
- 5-b. Discuss the tuple with Production rule of Regular Grammar. What are the rules for constructing Finite Automata from Regular Grammar. Construct a Finite Automata to accept the language generated by the following grammar. (CO2) 10
- $S \rightarrow 01A$
 $A \rightarrow 10B$

B ---> 0A / 11

6. Answer any one of the following:-

6-a. Write CFG for language $L = \{0^n 1^m 2^p\}$ where $n \leq m$ or $m \leq p$. (CO3) 10

6-b. Consider the grammar (CO3) 10

S ---> aB / bA

A ----> aS / bAA / a

B ---> bS / aBB / b

For the string aaabbabbba, find

(i) The left most derivation and left most derivation tree

(ii) The right most derivation and right most derivation tree

7. Answer any one of the following:-

7-a. Describe the Definition of Pushdown Automata. Is PDA more powerful than Finite Automata? if Yes than why? also Design PDA for Language $L = \{a^{m+n}b^m c^n \mid m, n > 1\}$ (CO4) 10

7-b. Construct a deterministic pda accepting $L = \{w \in \{a,b\}^* \mid \text{the number of a's in } w \text{ equal number of b's in } w\}$ by final state. (CO4) 10

8. Answer any one of the following:-

8-a. Explain any two of the following : (CO5) 10

(i) Universal Turing Machine

(ii) Recursively Enumerable Language

(iii) Halting Problem

(iv) Post's Correspondence Problem

8-b. Design a Turing machine which recognizes the language consisting of all strings of 0s whose length is a power of 2. i.e., it decides the language $L = \{0^{2^n} \mid n \geq 0\}$. (CO5) 10