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Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - THEORY EXAMINATION (2024 - 2025)

Subject: Formal Language & Automata Theory

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 20

1. Attempt all parts:-

1-a. The Kleene star (Σ*) is a _____ operator on a set of symbols . (CO1, K1) 1

(a) Unary

(b) Binary

(c) Both of above

(d) none of these

1-b. Finite Automata has ____ tuple. (CO1, K1) 1

(a) 5

(b) 4

(c) 3

(d) 6

1-c. Every grammar in Chomsky Normal Form is _____ .. (CO2, K1) 1

(a) Regular

(b) context sensitive

(c) context free

(d) all of the mentioned

1-d. More than one Parse tree can be generated from a same sentence. The Grammar which has this property are known as _____ . (CO2, K1) 1

(a) Ambiguous

.

(b) Unambiguous

(c) Ambiguous and Unambiguous

(d) Intersection

1-e. According to Church's thesis _____ . (CO3, K1) 1

(a) Anything done by the FSM can be easily done by Turing Machine

(b) Anything done by the digital computer can be easily done by PDA

(c) Any real-world computation can be translated into an equivalent computation involving a Turing Machine.

(d) None of these

1-f. Turing machine was invented in _____ by Alan Turing. (CO3, K1) 1

(a) 1938

(b) 1936

(c) 1836

(d) 1838

1-g. The following statement _____ is correct. (CO4,K1) 1

(a) A language 'L' is decidable if it is recursive language.

(b) A language 'L' is decidable if it is recursive enumerable language.

(c) A language 'L' is undecidable if it is recursive language.

(d) A language 'L' is not undecidable if it is recursive enumerable language.

1-h. If language 'L' is recursive language then it is _____ . (CO4, K1) 1

(a) Decidable.

(b) Undecidable

(c) Some time Decidable or Some time Undecidable

(d) None of above

1-i. The following Statement _____ is true about NP-Complete and NP-Hard problems. (CO5, K1) 1

(a) If we want to prove that a problem X is NP-Hard, we take a known NP-Hard problem Y and reduce Y to X

(b) The first problem that was proved as NP-complete was the circuit satisfiability problem.

(c) NP-complete is a subset of NP Hard

(d) All of the above

1-j. A problem which is both _____ and _____ said to be NP complete. (CO5, K1) 1

(a) NP, P

(b) NP, NP hard

(c) P, P complete

(d) None of the mentioned

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2. Attempt all parts:-

2.a.	List out different applications of Finite Automata. (CO1, K1)		2
2.b.	Construct a CFG which generate palindrome for binary numbers. (CO2, K3)		2
2.c.	Describe a short note on Universal Turing Machine. (CO3, K1)		2
2.d.	Differentiate between the terms Finite automata and a Turing machine. (CO4, K4)		2
2.e.	Differentiate between P and NP problem. (CO5, K4)		2

SECTION-B 30

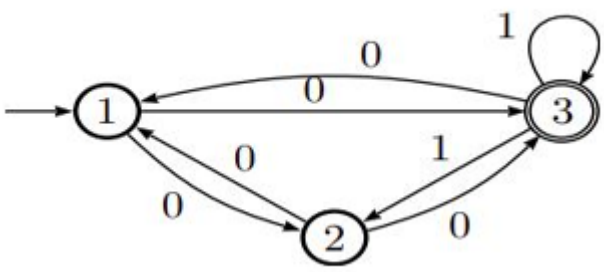
3. Answer any five of the following:-

3-a.	State Pumping Lemma and prove that $L=\{a^n b^{2n} n >=1\}$ is not regular. (CO1, K4)	6
3-b.	For $\Sigma = \{a,b\}$, Construct DFA's that accept the sets of strings: (CO1, K3) a) all strings with no more than three a's, b) all strings with at least one a and exactly two b's,	6
3-c.	Show that the grammar with following production is ambiguous. (CO2, K3) $S \rightarrow aS \ / \ Sa / a$	6
3-d.	Identified and remove all unit-productions from the following grammar (CO2, K3) S ---> A / bb A ---> B / b B ----> S /a	6
3.e.	Construct a Turing machine to compute the function (CO3, K3) $f(w)= ww^R$, where w^R is the reverse of string w . ($w \in (a,b)^*$)	6
3.f.	Differentiate between decidable Problems and undecidable Problems. (CO4, K4)	6
3.g.	State and Prove Cook's Theorem. (CO5, K4)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Discuss Chomsky's Hierarchy of formal languages. Explain briefly about DFA and NFA. (CO1, K2)	10
4-b.	Convert the following NFA into equivalent DFA. (CO1, K3)	10



5. Answer any <u>one</u> of the following:-

5-a.	Explain Chomsky Normal Form (CNF). Change the following grammar into CNF. (CO2, K3) S -----> abSb / a / aAb A -----> bS / aAAb	10
5-b.	Define Ambiguous Grammar. Show that the following grammar is ambiguous. (CO2, K3)) S ----> a / abSb / aAb A -----> bS / aAAb	10

6. Answer any <u>one</u> of the following:-

6-a.	Show that the union of two recursively enumerable languages is recursively enumerable and union of two recursive languages is recursive. (CO3,K4)	10
6-b.	Explain the working of Turing Machine. and Design a turing machine that replace every 0 and 1 with every 1 with 0 and every 0 with 1 in a binary string. (CO3, K3)	10

7. Answer any <u>one</u> of the following:-

7-a.	State **Rice's Theorem** and explain its importance in determining undecidability of language properties. (CO4, K2)	10
7-b.	Explain why the **Halting Problem** is undecidable. How does this lead to other undecidable problems in language theory? (CO4, K2)	10

8. Answer any <u>one</u> of the following:-

8-a.	State whether the time complexity of a nondeterministic Turing machine is always better than that of a deterministic one. Justify. (CO5, K2)	10
8-b.	Describe the relationship between P and NP classes with respect to time complexity. (CO5, K2)	10

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