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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.

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SECTION-A 20

1. Attempt all parts:-

1-a. The transition function δ of DFA is _____. (CO1, K1) 1

(a) $\delta: Q \times \Sigma \rightarrow 2Q$

(b) $\delta: Q \times q0 \rightarrow Q$

(c) $\delta: Q \times \Sigma \rightarrow Q$

(d) $\delta: Q \times q0 \rightarrow F$

1-c. Symbol _____ does not belong to CFG. (CO2, K1) 1

(a) Terminal Symbol

(b) End Symbol

(c) Start symbol

(d) Non Terminal

1-b. A language L is accepted by a FSM , if it is _____ . (CO1, K1) 1

(a) CFL

(b) CSL

(c) Recursive

(d) Regular

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. The transition function of Turing machine is _____ . (CO3, K1) 1

(a) δ : Q X Γ ---> Q X Γ X {L,R}

(b) δ : Q X Γ ---> Q X {L,R}

(c) δ : Q X (Σ U {λ}) X Γ ---> Q

(d) δ : Q X (Σ U {λ}) X Γ ---> Q

1-i. The following statement _____ is true. (CO5, K1) 1

(a) NP-complete problems are a subset of NP-Hard problems.

(b) NP-Hard problems are a subset of NP-complete problems.

(c) NP-complete and NP-Hard problems are the same.

(d) NP-complete problems can only be solved in polynomial time.

1-f. Recursively Enumerable languages can be accepted by _____. (CO3, K1) 1

(a) FSM

(b) TM

(c) DFA

(d) PDA

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

1-g. The 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. Halting problem is an example for _____ . (CO4, K1) 1

(a) Decidable problem

(b) undecidable problem

(c) complete problem

(d) traceable problem

2. Attempt all parts:-

2.a. Compare Non Deterministic Finite automata and Deterministic Finite Automata. (CO1, K2) 2

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2.b.	Explain the term "Church-Turing Thesis". (CO4, K2)	2
2.c.	Define the term "Context-Free Grammar" with an example. (CO2, K1)	2
2.e.	Explain the term P Class and NP Classe in brief. (CO5, K2)	2
2.d.	Define the term "Turing Machine". also List out the applications of Turing Machine. (CO3, K1)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	Explain the classification of formal languages into four types as per the Chomsky Hierarchy, providing examples for each type. (CO1, K2)	6
3-c.	Compare the terms Greibach Normal Forms and Chomsky Normal Forms with their examples. (CO2, K2)	6
3-b.	Design a DFA over alphabet $\Sigma=\{0,1\}$ which accepts the set of strings either start with 01 or end with 01. (CO1, K3)	6
3-d.	Construct a PDA which accepting the set of all strings over {a,b} with equal number of a's and b's. (CO2, K3)	6
3.e.	Construct a Turing Machine that recognizes the language of all strings of even length over alphabet {a,b}. {CO3, K3}	6
3.g.	State Cook's Theorem and define the concept of NP-completeness in computational complexity theory. (CO5, K1)	6
3.f.	Define a Universal Turing Machine (UTM) and explain its key components (CO4, K2)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Construct the following: (CO1, K3) (i) A DFA for the language L = { $(01)^i$ 1^{2j} i >=1, j >=1 }. (ii) A NFA for the language L = all strings over {0, 1} that have at least two consecutive 0's or 1's .	10
4-b.	Define Definition of Regular Expression. Write the regular expression for the language L = {a^n b^m / n > = 4, m <=3 }. also Construct an equivalent FA for the given regular expression (0+1)*(00+11)(0+1)* . (CO1, K3)	10

5. Answer any one of the following:-

5-a.	Explain the term "Ambigious Grammar". Let G be CFG: (CO2, K3) S --> AB / aaB A --> a / Aa B --> b for the string "aab" find : (i) left most derivation (ii) rightmost derivation (iii) Show that the following grammar is ambiguous.	10
5-b.	State Pumping Lemma for Context-Free Languages. Prove that language L = {a^n	10

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$b^n c^n$ / n > = 0} is not context free language. also List the closure properties of Context-Free Languages (CFLs) and provide examples for each property. (CO2, K2)

6. Answer any one of the following:-

6-a. Define a Non-Deterministic Turing Machine (NDTM) and a Deterministic Turing Machine (DTM). State the formal equivalence between NDTMs and DTMs. (CO3, K1) 10

6-b. Explain Formal Definition of Turing Machine. With a neat diagram, explain the working of a Turing Machine. Construct a Turing Machine that accepts the language of all strings which contain "aba" as a substring. (CO3, K3) 10

7. Answer any one of the following:-

7-a. Design and explain the process of converting a Turing machine into a Universal Turing Machine (UTM). Provide a detailed description of how a UTM simulates the behavior of a given Turing machine with an example. (CO4, K3) 10

7-b. Define recursive languages and recursively enumerable languages. Do you agree that every recursive language is also a recursively enumerable language? Justify your answer with proper reasoning and examples. (CO4, K4) 10

8. Answer any one of the following:-

8-a. Explain the concept of NP-completeness and Explain following terms: (CO5, K2) 10
(i) Satisfiability Problem (SAT)
(ii) Vertex Cover
(iii) Traveling Salesman Problem (TSP).
Describe the importance of these problems in real-world applications.

8-b. Explain the relationship between class P, NP, NP-complete and NP hard problem with example of each class. (CO5, K2) 10

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