Printed Page:- **Subject Code:- ACSBS0306**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - CARRY OVER THEORY EXAMINATION - APRIL 2023

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. In DFA the transition function δ is given by: (CO1) 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-b. Moore machine is having the output at (CO1) 1

(a) Transition

(b) State

(c) Both

(d) Initial State

1-c. Which of the following does not belong to CFG ? (CO2) 1

(a) Terminal Symbol

(b) End Symbol

(c) Start symbol

(d) Non Terminal

1-d. Grammar is defined by number of _____tuples. (CO2) 1

(a) 4

(b) 5

(c) 3

(d) 2

1-e. Turing machine was invented in _____ by Alan Turing.(CO3) 1

(a) 1938

(b) 1936

(c) 1836

(d) 1838

1-f. A Turing Machine can always move Left or _____. (CO3) 1

(a) Right

(b) Shift

(c) Up

(d) Down

1-g. If every string of a language can be determined, whether it is legal or illegal in finite time, the language is called _____. (CO4) 1

(a) Non-deterministic

(b) Deterministic

(c) Undecidable

(d) Decidable

1-h. Halting problem is an example for? (CO4) 1

(a) Decidable problem

(b) undecidable problem

(c) complete problem

(d) traceable problem

1-i. Which of the following is true about NP-Complete and NP-Hard problems.(CO5) 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. Which of the following statements are TRUE? (CO5) 1

(1) The problem of determining whether there exists a cycle in an undirected graph is in P.

(2) The problem of determining whether there exists a cycle in an undirected graph is in NP.

(3) If a problem A is NP-Complete, there exists a non-deterministic polynomial time algorithm to solve A.

(a) 1, 2 and 3

(b) 1 and 3

(c) 2 and 3

(d) 1 and 2

2. Attempt all parts:-

2.a. Differentiate between Non Deterministic Finite Automata and Deterministic Finite Automata. (CO1) 2

2.b. Differentiate between Right Linear Grammar and Left Linear Grammar with the help of suitable example. (CO2) 2

2.c. Define instantaneous description of a Turing Machine. (CO3) 2

2.d. Let M1 and M2 be arbitrary Turing machines. Show that the problem "L(M1) ⊆ (M2)" is undecidable. (CO4) 2

2.e. Describe Cook's Theorem in brief. (CO5) 2

SECTION B **30**

3. Answer any <u>five</u> of the following:-

3-a. Write regular expressions for the following languages on {0, 1}. (CO1) 6

(a) all strings ending in 01,

(b) all strings not ending in 01,

3-b. For Σ= {a,b}, Construct DFA's that accept the sets consisting of : (CO1) 6

a) all strings with no more than three a's,

b) all strings with at least one a and exactly two b's,

3-c. Remove all unit-productions, all useless productions, and all λ-productions from the grammar (CO2) 6

3-d. Convert the grammar into Greibach normal form. (CO2) 6

$$S \rightarrow ABb|a,$$
$$A \rightarrow aaA|B,$$
$$B \rightarrow bAb$$

3.e. Construct a Turing machine to compute the function (CO3) 6

$f(w) = w^R$, where $w \in \{0,1\}^+$.

3.f. Let G_1 be a context-free grammar and G_2 a regular grammar. Is the problem (CO4) 6

$L(G_1)\, L(G_2) = \emptyset$

decidable?

3.g. Is it possible that P = NP is undecidable? (CO5) 6

SECTION C **50**

4. Answer any one of the following:-

4-a. Find NFA's that accept the following languages. (CO1) 10

(a) L (aa* + aba*b*).

(b) L (ab (a + ab)* (a + aa)).

4-b. Convert the following NFA to equivalent DFA. p is the initial state and s is the final state. (CO1) 10

State/∑	0	1
p	{p,q}	{p}
q	{r}	{r}
r	{s}	
s	{s}	{s}

5. Answer any one of the following:-

5-a. Define Ambiguous Grammar. Show that the following grammar is ambiguous. (CO2) 10

$$S \rightarrow aSbS|bSaS|\lambda.$$

5-b. Construct PDA that accept the following languages on Σ = {a, b, c}. (CO2) 10

(a) $L = \{a^n b^{2n} : n \geq 0\}$.

(b) $L = \{wcw^R : w \in \{a, b\}^*\}$

6. Answer any one 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) 10

6-b. Prove that following function is turing computable. (CO3) 10

f(m) = m-2, if m > 2
1 , if m <=2

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

7-a. Describe the Universal Turing machine. Build a Turing Machine that accepts the language L = { $a^n b^{n+1}$ }. (CO4) 10

7-b. What do you understand by undecidable problem ? State the Halting Problem and prove that Halting problem is undecidable. (CO4) 10

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

8-a. Prove that the Satisfiability Problem(SAT) is NP-complete. (CO5) 10

8-b. Discuss the general plan for analyzing Time efficiency of recursive algorithm. (CO5) 10