Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2024

IT3CO33 Theory of Computation

Programme: B.Tech. Branch/Specialisation: IT

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Which of the following representations is used to represent Finite automate- **1**

(a) Transition graph (b) Transition matrix

(c) Transition function (d) All of these

ii. Moore Machine is an application of: **1**

(a) Finite automata without input

(b) Finite automata with output

(c) Non-Finite automata with output

(d) None of these

iii. Which of the following is not a part of 5-tuple finite automata? **1**

(a) Input alphabet (b) Transition function

(c) Initial state (d) Output alphabet

iv. NFA, in its name has 'non-deterministic' because of- **1**

(a) The result is undetermined

(b) The choice of path is non-deterministic

(c) The state to be transited next is non-deterministic

(d) All of these

v. The entity which generates language is termed as: **1**

(a) Automata (b) Tokens (c) Grammar (d) Data

vi. Which of the following is Unit production? **1**

(a) $X \rightarrow Y$ (b) $X \rightarrow x$ (c) $X \rightarrow y$ (d) All of these

vii. A pushdown automata can be defined as: $(Q, \sum, \partial, q_0, F, Z_0, \Gamma)$ **1**
What does the symbol Z_0 represent?

(a) An element of Γ (b) Initial stack symbol

(c) Top stack alphabet (d) All of these

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viii. Which of the following are the actions that operate on stack top? **1**
(a) Pushing (b) Popping (c) Replacing (d) All of these

ix. A Turing machine that is able to simulate other Turing machines: **1**
(a) Nested Turing machines
(b) Universal Turing machine
(c) Counter machine
(d) None of these

x. Decidable can be taken as a synonym to: **1**
(a) Recursive (b) Non recursive
(c) Recognizable (d) None of these

Q.2 i. What are finite automata? What are the types of FA? **2**

ii. Differentiate between Mealy and Moore machine. **3**

iii. Construct a Moore machine equivalent to the given Mealy machine- **5**

State	0		1	
	State	Output	State	Output
→ q 1	q 1	1	q 2	0
q 2	q 4	1	q 4	1
q 3	q 2	1	q 3	1
q 4	q 3	0	q 1	1

OR iv. Write a Regular Expression (RE) over ∑={a,b}* for following languages: **5**
(a) Language containing the string of length 2
(b) Language containing strings with exactly 2 b's
(c) Language containing strings with any number of a's and b's
(d) Set of strings starts and ends with different symbol
(e) Set of strings ending with abb

Q.3 i. Differentiate between DFA and NFA. **4**

ii. Explain the pumping lemma for regular languages. Show that the language L = {a^p | p is prime number} is not regular. **6**

OR iii. Construct a minimal DFA over ∑={a,b}*: **6**
(a) That accept the set of all strings, which starts with 'a' and ends with 'b'
(b) That accept the set of all strings, in which every 'a' is followed by "bb"
(c) That accept the set of all strings, in which every "a" is not followed by "bb"

Q.4 i. Explain Chomsky's classification of grammar. **4**

ii. Remove all unit-production, useless production, and ε-production from the given grammar: **6**
S → aA/ aBB
A → aaA/ ε
B → bB/ bbC
C → B

OR iii. Convert the following grammar in CNF and GNF: **6**
S → 1A/ 0B
A → 0S/ 0
B → 1S/ 1

Q.5 i. Define PDA with an example. **3**

ii. Construct a PDA for L = a^n b^n | n>=1. Also simulate this PDA for string "aaaabbbb". **7**

OR iii. Construct a PDA for the given CFG: **7**
S → AB
A → CD
B → b
C → a
D → a
Derive the string "aab" from the resultant PDA.

Q.6 Attempt any two:

i. What do you mean by Turing machine? Design a Turing machine for language L = W W^R | W ∈ {a, b}*. **5**

ii. Explain various types of Turing machine. **5**

iii. Differentiate between decidable and undecidable problems. **5**

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Marking Scheme

Theory of Computation (T) - IT3CO33 (T)

Q.1 i) Which of the following representations is used to represent Finite automate- **1**
d) All of the above

ii) Moore Machine is an application of: **1**
b) Finite automata with output

iii) Which of the following is not a part of 5-tuple finite automata? **1**
d) Output Alphabet

iv) NFA, in its name, has 'non-deterministic' because of : **1**
b) The choice of path is non-deterministic

v) The entity which generates Language is termed as: **1**
c) Grammar

vi) Which of the following is Unit production: **1**
a) X -> Y

vii) A pushdown automata can be defined as: (Q, ∑, G, q0, Z0, A, d) **1**
What does the symbol Z0 represent?
d) all of the mentioned

viii) Which of the following are the actions that operate on stack top? **1**
d) All of the mentioned

ix) A Turing machine that is able to simulate other Turing machines: **1**
b) Universal Turing machine

x) Decidable can be taken as a synonym to: **1**
a) recursive

Q.2 i. What is Finite Automata? What are the types of FA? **2**
Definition – 1 mark
Types – 1 mark

ii. Differentiate between Mealy and Moore machine. **3**
Difference – 3 marks

iii. Write a Regular Expression (RE) over ∑={a,b}* for following languages: **5**

1. Language containing the string of length 2.
   RE = (a+b) (a+b)
2. Language containing strings with exactly 2 b's.
   RE = a* b a* b a*
3. Language containing strings with any number of a's and b's.
   RE = a* b*
4. Set of strings starts and ends with different symbol
   RE = (a (a+b)* b) + (b (a+b)* a)
5. Set of strings ending with the string abb
   RE = (a+b)* a b b

1 mark for each RE

OR iv. Construct a Moore Machine equivalent to the given Mealy Machine. **5**

State	0		1	
	State	Output	State	Output
→q 1	q 1	1	q 2	0
q 2	q 4	1	q 4	1
q 3	q 2	1	q 3	1
q 4	q 3	0	q 1	1

Problem Solution – 5 Marks

Q.3 i. Differentiate between DFA and NFA. **4**
DFA – 2 Marks
NFA – 2 Marks

ii. Explain the Pumping lemma for Regular languages. Show that the language L = {a^p | p is prime number} is not regular. **6**
Definition – 2 Marks
Problem Solution – 4 Marks

OR iii. Construct a minimal DFA over ∑={a,b}* **6**

1. that accept the set of all strings, which starts with 'a' and ends with 'b'
2. that accept the set of all strings, in which every "a" is followed by "bb"

Problem Solution of each – 2 Marks

Q.4 i. Explain Chomsky's Classification of Grammar. **4**
4 types of Grammar – 1 Mark each

ii. Remove all unit-production, useless production, and ε-production from the given grammar: **6**
S -> aA/ aBB
A -> aaA/ ε
B -> bB/ bbC
C -> B
Unit production – 2 Marks
Useless production – 2 Marks
Null production – 2 Marks

OR iii. Convert the following grammar in CNF and GNF: **6**
S -> 1A/ 0B
A -> 0S/ 0
B -> 1S/ 1
Conversion in each form 3 Marks

Q.5 i. Define PDA with an example. **3**

Definition – 1.5 Mark
Example – 1.5 Mark

ii. Construct a PDA for L = $a^n b^n$ | n>=1. Also simulate this PDA for string “aaaabbbb”. **7**
PDA Construction – 4 Marks
Simulation of string – 3 Marks

OR iii. Construct a PDA for the given CFG: **7**
S -> AB
A -> CD
B -> b
C -> a
D -> a
Derive the string “aab” from the resultant PDA.
PDA Construction – 4 Marks
Simulation of string – 3 Marks

Q.6 Attempt any two:

i. What do you mean by Turing Machine? Design a Turing Machine for language L = W W^R | W Є {a, b}*. **5**
Definition – 2 Marks
Turing Machine Design – 3 Marks

ii. Explain various types of Turing Machine. **5**
Types – 5 Marks

iii. Differentiate between Decidable and Undecidable Problems. **5**
Description of each – 2.5 Marks

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