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

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2022

CB3CO22 Formal Language & Automata Theory

Programme: B.Tech. Branch/Specialisation: CSBS

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.

Q.1 i. The regular expressions denote a language comprising all possible strings of even length over the alphabet (0,1). **1**

(a) 1+0(1+0)* (b) (0+1)(1+0)*

(c) (1+0) (d) (00+0111+10)*

ii. Myhill-Nerode theorem is used for- **1**

(a) Finding equivalent classes

(b) Minimization of FA

(c) Proving regular or not regular

(d) All of these

iii. The intersection of context free language and regular language is- **1**

(a) Always regular

(b) Always context free

(c) Both regular and context free language

(d) need not be regular

iv. The CFG G: S→aS|bS|a|b generate **1**

(a) $(a+b)^+$ (b) (a+b) (a+b)*

(c) (a+b)*(a+b) (d) All of these

v. Which one of the following is **false**? **1**

(a) There is unique minimal DFA for every regular language

(b) Every NFA can be converted to an equivalent DFA

(c) Every NFA can be converted to an equivalent PDA

(d) Every nondeterministic PDA can be converted to an equivalent deterministic PDA.

P.T.O.

vi. Context sensitive grammar (CSL) is also called? **1**
(a) Length increasing grammar
(b) Non contracting Grammar
(c) Type 1 Grammar
(d) All of these

vii. Which of the following statement is correct? **1**
(a) Recursively language are closed under complementation.
(b) If a language and its complement are both recursively enumerable, then language is recursive.
(c) Set of recursive enumerable language is closed under union.
(d) All of these

viii. Let L1 be the regular language, L2 be a DCFL and L3 be a recursively enumerable (R.E.) but not recursive language, which one of the following statements is false? **1**
(a) L1∩L2 is a DCFL
(b) L3∩L1 is recursive
(c) L1ỤL2 is a CFL
(d) L1∩L2∩L3 is a R.E.

ix. What is the solution for the PCP (Post Corresponding Problem) system with two lists: **1**
(a) 3231 (b) 1231 (c) 3213 (d) No Solution

x. Which one of the following problems is undecidable? **1**
(a) Equivalence problem for FSAs
(b) Ambiguity problem for CFGs
(c) Finiteness problem for FSAs
(d) Memberships problem for CFGs

Q.2 i. What is the significance of automata theory in computer science? Also, explain Chomsky hierarchy of language with diagram. **4**

ii. Construct DFA for all accepting string over {a,b} having 3rd symbols from end (RHS) must be 'b'. **6**

OR iii. What is the difference between DFA, NFA & NFA with e-moves? Explain with an example. **6**

Q.3 i. Describe the closure properties of regular language with an example. **5**

ii. Construct a grammar into GNF equivalent to grammar- **5**
S→AA|a
A→SS|b

OR iii. Let G be the grammar- **5**
S→aB|bA
A→a|aS|bAA
B→b|bS|aBB
for the string aaabbabbba find
(a) Leftmost derivation (b) Rightmost derivation
(c) Parse tree (d) Is the grammar unambiguous?

Q.4 i. Differentiate between "PDA by empty stack" and "PDA by final state". **4**

ii. Construct pushdown automata for the language: **6**
(a) $L=\{a^n b^{2n} | n\geq 1\}$ (b) $L=\{a^n b^m c^m d^n | n,m\geq 1\}$

OR iii. Obtain CFG for the PDA as given below: **6**
$M=(\{q_0,q_1\},\{0,1\},\{X,Z_0\},\delta,q_0,Z_0,\varnothing)$
where δ is given by
$\delta(q_0,0,Z_0)=\{(q_o,XZ_0)\}$ $\delta(q_0,1,X)=\{(q_1,\varepsilon)\}$
$\delta(q_0,0,X)=\{(q_o,XX)\}$ $\delta(q_1,\varepsilon,X)=\{(q_1,\varepsilon)\}$
$\delta(q_0,1,X)=\{(q_1,\varepsilon)\}$ $\delta(q_1,\varepsilon,Z_0)=\{(q_1,\varepsilon)\}$

Q.5 i. Explain different types of turing machines. **4**

ii. Explain closure properties of recursive language. **6**

OR iii. Design a turing machine for the language L over {a,b,c}: **6**
$L=\{a^n b^n c^n | n>=1\}$

Q.6 i. Explain church hypothesis. **5**

ii. Prove that the halting problem of the turing machine is undecidable. **5**

OR iii. Explain the following terms: **5**
(a) P (b) NP (c) NP-Complete

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Marking Scheme

CB3CO22 Formal Language & Automata Theory

Q.1	i)	The regular expressions denote a language comprising all possible strings of even length over the alphabet (0,1). a) 1+0(1+0)* b) (0+1)(1+0)* c) (1+0) **d) (00+0111+10)* (ANSWER)**	**1**
	ii)	Myhill-Nerode theorem is used for (a) Finding equivalent classes (b) Minimization of FA (c) Proving regular or not regular **(d) All of the above statement (ANSWER)**	**1**
	iii)	The intersection of Context Free language and regular language is (a) Always regular **(b) always context free (ANSWER)** (c) both regular and Context Free language (d) need not be regular	**1**
	iv)	The CFG G: S→aS|bS|a|b generate a) $(a+b)^+$ b) (a+b) (a+b)* c) (a+b)*(a+b) **d) All the above (ANSWER)**	**1**
	v)	Which one of the following is FALSE? (a) There is unique minimal DFA for every regular language (b) Every NFA can be converted to an equivalent DFA (c) Every NFA can be converted to an equivalent PDA **(d) Every Nondeterministic PDA can be converted to an equivalent Deterministic PDA. (ANSWER)**	**1**
	vi)	Context sensitive grammar (CSL) is also called? (a) Length increasing grammar (b) Non contracting Grammar (c) Type 1 Grammar (d) All of these **(ANSWER)**	**1**
	vii)	Which of the following statement is correct? a) Recursively language are closed under complementation. b) If a language and its complement are both recursively enumerable then language is recursive. c) Set of recursive enumerable language is closed under union. d) **All of these. (ANSWER)**	**1**
	viii)	Let L1 be the regular language, L2 be a DCFL and L3 be a recursively enumerable (R.E.) but not recursive language, which one of the following statements is false? a) L1∩L2 is a DCFL **b) L3∩L1 is recursive (ANSWER)** c) L1ỤL2 is a CFL d) L1∩L2∩L3 is a R.E.	**1**
	ix)	What is the solution for the PCP (Post Corresponding Problem) system with two lists: a) **3231 (ANSWER)** b) 1231 c) 3213 d) No Solution	**1**
	x)	Which one of the following problems is undecidable? a) Equivalence problem for FSAs **b) Ambiguity problem for CFGs (ANSWER)** c) Finiteness problem for FSAs d) Memberships problem for CFGs	**1**
Q.2	i.	What is the significance of Automata Theory in Computer Science. Also, explain Chomsky hierarchy of language with diagram. **(2+2)**	**4**
	ii.	Construct DFA for all accepting string over {a,b} having 3rd symbols from end (RHS) must be 'b'	**6**
OR	iii.	What is difference between DFA, NFA & NFA with e-moves, explain with an example. **(at least 2 Points from each 2*3)**	**6**
Q.3	i.	Describe the closure properties of Regular Language with an example. **(Mention at least 5 properties 1*5)**	**5**
	ii.	Construct a grammar into GNF equivalent to grammar- S→AA|a A→SS|b	**5**
OR	iii.	Let G be the grammar- S→aB|bA A→a|aS|bAA B→b|bS|aBB for the string aaabbabbba find i) Leftmost Derivation **(1 mark)**	**5**

		ii) Rightmost Derivation **(1 mark)** iii) Parse tree **(2 marks)** iv) Is the grammar unambiguous? **(1 mark)**	
Q.4	i.	Differentiate between "PDA by empty stack" and "PDA by final state". **(2+2)**	**4**
	ii.	Construct Pushdown Automata for the language: a) $L=\{a^n b^{2n} \mid n\geq 1\}$ **(3 Marks)** b) $L=\{a^n b^m c^m d^n \mid n,m\geq 1\}$ **(3 Marks)**	**6**
OR	iii.	Obtain CFG for the PDA as given below: $M=(\{q_0,q_1\},\{0,1\},\{X,Z_0\},\delta,q_0,Z_0,\omega)$ where δ is given by $\delta(q_0,0,Z_0)=\{(q_o,XZ_0)\}$ $\delta(q_0,1,X)=\{(q_1,\varepsilon)\}$ $\delta(q_0,0,X)=\{(q_o,XX)\}$ $\delta(q_1,\varepsilon,X)=\{(q_1,\varepsilon)\}$ $\delta(q_0,1,X)=\{(q_1,\varepsilon)\}$ $\delta(q_1,\varepsilon,Z_0)=\{(q_1,\varepsilon)\}$	**6**
Q.5	i.	Explain different types of Turing machines. **(4 points- 1*4)**	**4**
	ii.	Explain closure properties of Recursive Language.	**6**
OR	iii.	Design a Turing Machine for the language L over {a,b,c}: $L=\{a^n b^n c^n \mid n>=1\}$	**6**
Q.6	i.	Explain Church Hypothesis.	**5**
	ii.	Prove that the halting problem of the Turing machine is undecidable.	**5**
OR	iii.	Explain the following terms: a) P **(2 Marks)** b) NP **(2 Marks)** c) NP-Complete **(1 Marks)**	**5**

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