

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November-December 2015

B. Tech in Computer Science Engineering, Semester V

Subject Code: CSE 504

Roll No.....

Subject Name: Theory of Computation

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark) 10

- i. Consider the regular language $L = (111 + 11111)^*$. The minimum number of states in any DFA accepting this language is
(a) 3 (b) 5 (c) 8 (d) 9
- ii. Let ω be any string of length n in $\{0, 1\}^*$. Let L be the set of all substring of ω . What is the minimum number of states in a non-deterministic finite automation that accepts L ?
(a) $n - 1$ (b) n (c) $n + 1$ (d) 2^{n+1}
- iii. Which of the following is TRUE?
(a) Every subset of a regular set is regular
(b) Every finite subset of a non-regular set is regular
(c) The union of two non-regular sets is regular
(d) Infinite union of finite sets is regular
- iv. Which of the following are regular sets?
1. $\{a^n b^{2m} \mid n \geq 0, m \geq 0\}$ 2. $\{a^n b^m \mid n = 2m\}$ 3. $\{a^n b^{2m} \mid n \neq m\}$ 4. $\{xycy \mid x, y \in \{a, b\}^*\}$
(a) 1 and 4 only (b) 1 and 3 only (c) 1 only (d) 4 only
- v. The language generated by the grammar $G = (\{S\}, \{a, b\}, \{S \rightarrow aSa \mid bSb \mid a \mid b\}, S)$ over the alphabet $\{a, b\}$ is the set of
(a) all palindromes
(b) all odd length palindromes
(c) strings that begin and end with the same symbol
(d) all even length palindromes
- vi. Consider the following statements about the context-free grammar $G = (\{S\}, \{a, b\}, \{S \rightarrow SS \mid ab \mid ba \mid \Lambda\}, S)$,
1. G is ambiguous.
2. G produces all strings with equal number of a 's and b 's.
3. G can be accepted by a deterministic PDA.
Which combination below expresses all the true statements about G ?
(a) 1 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3
- vii. The intersection of a context-free language and a regular language is
(a) context-free (b) regular but not context-free
(c) neither context-free nor regular (d) both regular and context-free

viii. In a deterministic PDA:

- (a) $\delta(q, a, Z) = \emptyset \Rightarrow \delta(q, \Lambda, Z) \neq \emptyset$ (b) $\delta(q, a, Z) \neq \emptyset \Rightarrow \delta(q, \Lambda, Z) = \emptyset$
 (c) $\delta(q, \Lambda, Z) \neq \emptyset \Rightarrow \delta(q, a, Z) \neq \emptyset$ (d) $\delta(q, \Lambda, Z) \neq \emptyset \Rightarrow \delta(q, a, Z) = \emptyset$

ix. Which of the following is true for the language $\{a^p \mid p \text{ is a prime}\}$

- (a) It is not accepted by a Turing Machine
 (b) It is regular but not context-free
 (c) It is context-free but not regular
 (d) It is neither regular nor context-free, but accepted by a Turing Machine

x. Which of the following problems is undecidable?

- (a) Membership problem for CFGs (b) Ambiguity problem for CFGs
 (c) Finiteness problem for FSAs (d) Equivalence problem for FSAs

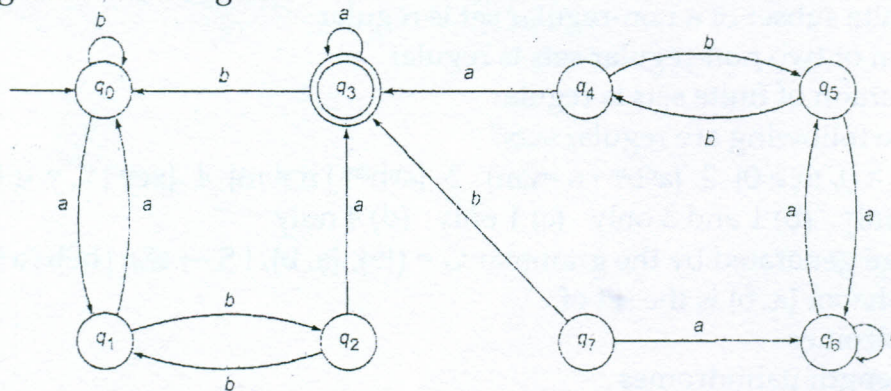
Q.2 Short answer type questions (4 questions @ 2.5 marks)

10

- i. Construct a DFA accepting all strings w over $\{0, 1\}$ such that the number of 1's in w is $2 \pmod 3$.
 ii. Prove that $\Lambda + 1^*(011)^*(1^*(011)^*)^* = (1 + 011)^*$
 iii. Find a context-free grammar generating $\{a^i b^n c^m : n \geq 1, i \geq 0\}$
 iv. Find the language generated by the context-free grammar
 $G = (\{S, A, B\}, \{0, 1\}, \{S \rightarrow 0S1 \mid 0A \mid 0 \mid 1B \mid 1, A \rightarrow 0A \mid 0, B \rightarrow 1B \mid 1\}, S)$.

Q.3A Construct the minimum state automaton equivalent to the DFA represented by following transition diagram

05

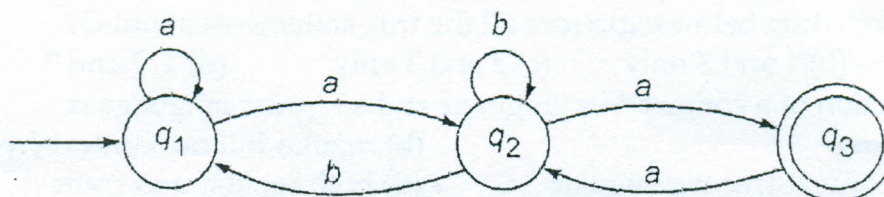


Q.3B Construct a Moore machine which calculates residue mod - 3 for each binary string treaded as binary integer. Convert this Moore machine into an equivalent Mealy machine.

05

Q.4A Construct a DFA equivalent to an N DFA defined by the following transition diagram:

05



Q.4B Find the regular expression corresponding to the automaton described by the transition diagram given in Q.4(A).

05

Q.5A	Using the pumping lemma, show that the set $L = \{a^p \mid p \text{ is a prime}\}$ is not regular.	05
Q.5B	Find the reduced grammar equivalent to the following context-free grammar: $G = (\{S, A, C, D, E\}, \{a, b\}, \{S \rightarrow aAa, A \rightarrow Sb \mid bCC \mid DaA, C \rightarrow abb \mid DD, D \rightarrow aDA, E \rightarrow aC\}, S)$	05
Q.6A	Prove that the grammar $G = (\{S, A\}, \{a, b\}, \{S \rightarrow abSb \mid aAb \mid a, A \rightarrow bS \mid aAAb\}, S)$ is ambiguous.	05
Q.6B	Reduce the grammar given in Q.6 (A) into Chomsky Normal Form (CNF).	05
OR		
Q.6B	Enlist and briefly explain the decision algorithms for context-free languages.	05
Q.7A	Reduce the following grammar G to Greibach normal form (GNF): $G = (\{S, A, B\}, \{0, 1\}, \{S \rightarrow A0, A \rightarrow 0B, B \rightarrow A0 \mid 1\}, S)$	05
Q.7B	Construct a deterministic PDA A accepting $L = \{wcw^T \mid w \in \{a, b\}^*\}$ by final state.	05
OR		
Q.7B	Construct a PDA A equivalent to the following context-free grammar $G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow aS \mid bS \mid aA, A \rightarrow bB, B \rightarrow a\}, S)$. Test whether $aaba$ is in $N(A)$.	05
Q.8A	Construct a PDA accepting $\{a^m b^n c^m \mid m, n \geq 1\}$ by null store. Construct the corresponding context-free grammar accepting the same set.	10
Q.9A	Design a Turing Machine that accepts $\{a^n b^n \mid n \geq 1\}$. Also check its validity through sequence of Instantaneous Descriptors (IDs) for one correct string and wrong string.	10
Q.9B i.	Does the PCP with two lists $x = (1, 10, 1011)$ and $y = (111, 0, 10)$ have a solution?	5
ii.	Given the function $f_1(x, y) = x + y$, prove that the function $f_2(x, y) = x * y$ is primitive recursive.	5
OR		
Q.9B	Write short note on the following (any two) (a) Myhill-Nerode theorem (b) Two stack PDA (c) Variants of Turing Machine (d) Halting problem of TM	10