

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

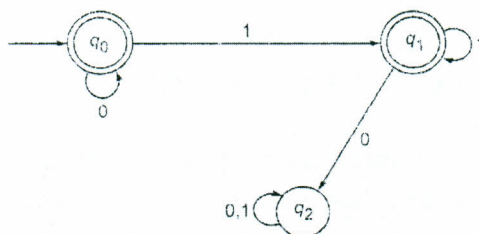
Time: 3 hours

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
Study the DFA M given in below Figure and choose the correct answers to questions i and ii:



- M does not accepts
(a) 00111 (b) 01111 (c) 00010 (d) Λ
- The language accepted by this DFA is given by the regular expression
(a) $(0 + 1)^*$ (b) 0^*1^* (c) 0^*11^* (d) $(01+10)^*$
- The regular expression $(0 + 1)^*0(0 + 1)^*0(0 + 1)^*$ describes the language over $\{0, 1\}$ which is the set of all strings:
(a) containing the substring 00 (b) containing at most two 0's
(c) containing at least two 0's (d) that begin and end with either 0 or 1
- Which of the following is FALSE?
(a) There is a unique minimal DFA for every regular language
(b) Every NFA can be converted to an equivalent NPDA
(c) Complement of every context-free language is recursive
(d) Every NPDA can be converted to an equivalent DPDA
- Consider the languages
 $L_1 = \{a^n b^m c^m \mid n, m > 0\}$ and $L_2 = \{a^n b^m c^m \mid n, m > 0\}$
Which one of the following statements is FALSE?
(a) $L_1 \cap L_2$ is a CFL (b) $L_1 \cup L_2$ is a CFL
(c) L_1 and L_2 are CFLs (d) $L_1 \cap L_2$ is a context-sensitive language
- Consider the following context-free grammar G as follows:
 $G = (\{S\}, \{a, b\}, \{S \rightarrow bS \mid aA \mid b, A \rightarrow bA \mid aB, B \rightarrow bB \mid aS \mid a\}, S)$
Let $N_a(w)$ and $N_b(w)$ denote the number of a 's and b 's in a string w respectively.
The language $L(G) \subseteq \{a, b\}^+$ generated by G is
(a) $\{w \mid N_a(w) > 3 N_b(w)\}$ (b) $\{w \mid N_b(w) > 3 N_a(w)\}$

	(c) $\{w \mid N_a(w) = 3k, k \in \{0, 1, 2, \dots\}\}$ (d) $\{w \mid N_b(w) = 3k, k \in \{0, 1, 2, \dots\}\}$
vii.	Consider the context-free grammar $G = (\{S\}, \{a, b\}, \{S \rightarrow aSb \mid SS \mid \Lambda\}, S)$, which of the following statements is TRUE? (a) G is not ambiguous (b) There exist $x, y \in L(G)$ such that $xy \notin L(G)$ (c) There is a DPDA that accepts $L(G)$ (d) We can find a DFA that accepts $L(G)$
viii.	The language $L = \{0^i 21^i \mid i \geq 0\}$ over the alphabet $\{0, 1, 2\}$ is (a) not recursive (b) recursive and deterministic CFL (c) a regular language (d) not a deterministic CFL but a CFL
ix.	Let D_f, N_f, D_p and N_p denote the classes of languages accepted by DFA, NFA, DPDA and NPDA, respectively. Which one of the following is TRUE? (a) $D_f \subset N_f$ and $D_p \subset N_p$ (b) $D_f \subset N_f$ and $D_p = N_p$ (c) $D_f = N_f$ and $D_p = N_p$ (d) $D_f = N_f$ and $D_p \subset N_p$
x.	If L and $\bar{L}$ are recursively enumerable then L is (a) regular (b) context-free (c) context-sensitive (d) recursive

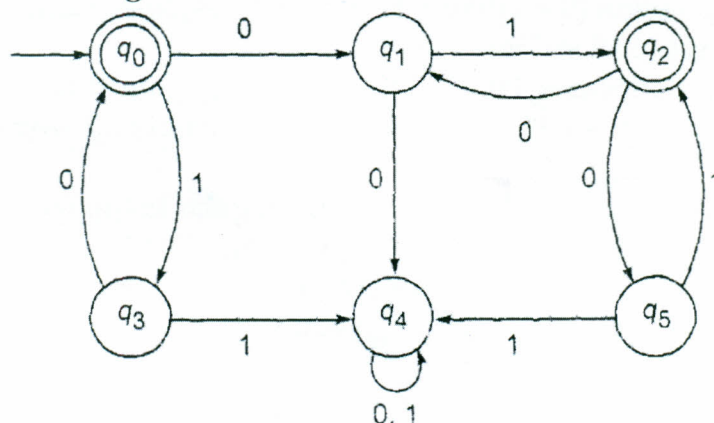
Q.2 Short answer type questions (4 questions @ 2.5 marks)

10

- Construct a DFA accepting all strings w over $\{0, 1\}$ such that the number of 1's in w is multiple of 3.
- Prove that $P + PQ^*Q = a^*bQ^*$ where $P = b + aa^*b$ and Q is any regular expression.
- Find a context-free grammar generating $\{a^n b^n c^i : n \geq 1, i \geq 0\}$
- Find the language generated by the context-free grammar $G = (\{S, A, B\}, \{0, 1\}, \{S \rightarrow 0S1 \mid 0A1, A \rightarrow 1A \mid 1\}, S)$.

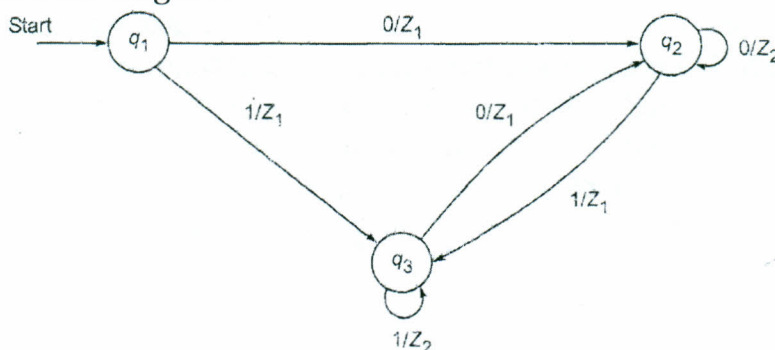
Q.3A Construct the minimum state automaton equivalent to the DFA represented by following transition diagram

05



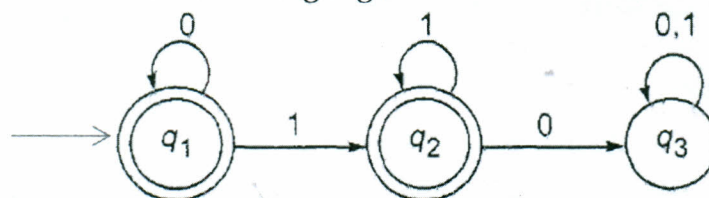
Q.3B Construct a Moore machine equivalent to the Mealy machine represented by the following transition diagram:

05



Q.4A Construct a nondeterministic finite automaton accepting the set of all strings over $\{a, b\}$ ending in aba. Use it to construct a DFA accepting the same set of strings. 05

Q.4B Describe in English the set accepted by the finite automaton whose transition diagram is as shown in following Figure: 05



Q.5A Using the pumping lemma, show that the set $L = \{0^n 1^n \mid n \geq 1\}$ is not regular. 05

Q.5B Find the reduced grammar equivalent to the following context-free grammar:
 $G = (\{S, A, B, C\}, \{a, b\}, \{S \rightarrow aAa, A \rightarrow bBb, B \rightarrow ab, C \rightarrow aB\}, S)$ 05

Q.6A Prove that the grammar $G = (\{S, A\}, \{a, b\}, \{S \rightarrow aB \mid ab, A \rightarrow aAB \mid a, B \rightarrow ABb \mid b\}, S)$ is ambiguous. 05

Q.6B Reduce the grammar given in Q.6 (A) into Chomsky Normal Form (CNF).
 OR 05

Q.6B Prove that the class of context-free languages, $\mathcal{L}_{cfl}$, is closed under union. 05

Q.7A Reduce the following grammar G to Greibach normal form (GNF):
 $G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow ABb \mid a, A \rightarrow aaA, B \rightarrow bAb\}, S)$ 05

Q.7B Construct a deterministic PDA A accepting $L = \{a^n b^{2n} \mid n \geq 1\}$ by final state.
 OR 05

Q.7B Construct a PDA A equivalent to the following context-free grammar
 $G = (\{S, A\}, \{a, b\}, \{S \rightarrow aS \mid bA \mid b, A \rightarrow aA \mid bS \mid a\}, S)$. Test whether $aaba \in N(A)$. 05

Q.8A Construct a PDA accepting $\{a^m b^n c^n \mid m, n \geq 1\}$ by null store. Construct the corresponding context-free grammar accepting the same set. 10

Q.9A Construct a TM to accept the set L of all strings over $\{0, 1\}$ ending with 010. 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 $x = (ba, b, bab^3)$ and $y = (a, b^3, ba)$ have a solution? 5
 ii. Show that the function $f_1(x, y) = x + y$ is primitive recursive. 5

OR
 Q.9B Write short note on the following (any two) 10
 (a) Myhill-Nerode theorem
 (b) Decision algorithms of context-free languages
 (c) Variants of Turing Machine
 (d) Decidability of a problem