Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEM-VI Examination-Nov/Dec-2011

Subject code: 160704 **Date: 28/11/2011**

Subject Name: Theory of Computation

Time: 10.30 am -1.00 pm **Total marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Languages L1 and L2 are the subsets given below. Where $\sum = \{ 0 , 1 \}$ **05**

L1 = { x | 00 is not a substring of x }

L2 = { x | x ends with 01 }

Draw FAs recognizing the following languages

(i) L1 - L2 (ii) L1∩L2

(b) Draw an DFA that recognize the language of all strings of 0's and 1's of length at least 1 that, if they were interpreted as binary representation of integers, would represent evenly divisible by 3. Your DFA should accept the string 0 but no other strings with leading 0's. **05**

(c) Enlist applications where the finite automaton is useful. Also Find a string of minimum length in {0,1}* not in the language corresponding to the regular expression : 1*(0+10)*1* **04**

Q.2 **(a)** Explain the procedure for converting the given DFA in to minimum number of state DFA. Using this procedure convert the following DFA into minimum number of states DFA (minimized FA) where $\sum = \{0,1\}$. **07**

Q	δ(q,a)	δ(q,b)
- +1	{3}	{2}
2	{4}	{1}
3	{5}	{4}
4	{4}	{4}
5	{3}	{2}

(b) For the following CFG's, describe the language it accepts. **05**

1. S → SS | XaXaX | ^
   X → bX | ^

2. S → aM | bS
   M → aF | bS
   F → aF | bF | ^

3. S → aS | bS | a | b | ^

(c) Give definition of Context-Free Grammars. **02**

OR

(b) Find CFG for the following languages. **05**

1. $L = \{ a^i b^j a^k \mid j > i + k \}$
2. $L = \{ a^i b^j c^k \mid i = j \text{ or } j = k \}$

(c) Give definition of Regular Grammars. **02**

Q.3 **(a)** Give transition table for deterministic PDA recognizing the following language. **07**

$\{ a^n b^{n+m} a^m \mid n,m \geq 0)$

(b) Draw a transition diagram for a Turing machine accepting the following language. **07**
$\{ a^n b^n c^n \mid n \geq 0 \}$

OR

Q.3 (a) Give transition table for deterministic PDA recognizing the following language. **07**
$\{ a^i b^j c^k \mid i, j, k \geq 0 \text{ and } j = i \text{ or } j = k \}$

(b) Draw a transition diagram for a Turing machine accepting the following language. **07**
$\{ x \in \{ a, b, c \}^* \mid n_a(x) = n_b(x) = n_c(x) \}$

Q.4 (a) Find unrestricted grammar to generate the following language, **07**
$\{ a^n x b^n \mid \geq 0, x \in \{a, b\}^*, |x| = n \}$

(b) Given the context-free grammar G, find a CFG G' in Chomsky Normal Form generating L(G) – {^}. **05**

G has production $S \rightarrow S(S) \mid \wedge$

(c) Define Dead-End State with Example. **02**

OR

Q.4 (a) Consider the following NFA-^. **07**

Q	δ(q, ^)	δ(q, 0)	δ(q, 1)
-A	{B}	{A}	Ø
B	{D}	{C}	Ø
C	Ø	Ø	{B}
+D	Ø	{D}	Ø

[1] Convert this NFA-^ into its equivalent NFA.

[2] Take this NFA as an input and convert it into equivalent DFA

(b) Define Pumping Lemma for Regular Languages. **05**
Prove that the language $L = \{a^n : n \text{ is a prime number}\}$ is not regular.

(c) Check the validity of the following equality with proper reason. **02**
$(00^*1)^*1 = 1 + 0(0 + 10)^*11$

Q.5 (a) Give definitions of the following. **07**

[1] Initial Functions
[2] Composition
[3] The Primitive Recursive Functions

(b) Give definitions of the following. **07**

[1] Polynomial-time Reducibility
[2] NP-hard and NP-complete languages
[3] The Sets P, NP, PSpace and NPSpace

OR

Q.5 (a) Show that the uncomputability of the given busy-beaver function implies the unsolvability of the halting problem. **07**
Busy Beaver function, $b : N \rightarrow N$ as follows, b(0) is 0. For n > 0, b(n) is obtained by considering TMs having n nonhalting states and tape alphabet {0, 1}.

(b) Give definitions of the following. **07**

[1] Basic complexity Classes
[2] Step-counting Functions
[3] The Time and Space Complexity of a Turing Machine
