Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEMESTER – VI • EXAMINATION –Summer-2015

Subject Code: 160704 Date:14/05/2015

Subject Name: Theory of Computation

Time:10.30AM-01.00PM 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)** Define Mathematical Induction Principle and Prove that for every $n \geq 0$, **07**

$$\sum_{i=0}^{N} i = n(n+1)/2$$

(b) (i) Suppose that Languages L1 and L2 are the subsets given below. **05**

Where $\Sigma = \{ 0 , 1 \}$

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

L2 = { x | x ends with 01 }

Draw FAs recognizing the following languages

(1) L1 - L2 (2) L1∩L2

(ii) Show that the function $f_1(x,y) = x + y$ is primitive recursive. **02**

Q.2 **(a)** Write definition of finite automata and draw FA for the strings: **07**

(i) The string in {0,1}* ending in 10 or 11

(ii) The string corresponding to Regular expression {11}*{00}*

(b) Define Context Free Grammar(CFG). Design CFG for Generating Following Language: **07**

(1) For Balanced Parenthesis

(2) Set of even length strings in {a, b, c, d}* with two middle symbol equal.

OR

(b) Design an ambiguous grammar for if-then-else statement that also generates if-then statement. Re-write an equivalent unambiguous grammar. Prove that Grammar is Unambiguous by tracing "ic_1tic_2taea". **07**

Q.3 **(a)** Convert NFA-^ to NFA and DFA. Initial State: A , Final State: D **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

(b) Define Pumping Lemma for Regular Languages. Use Pumping Lemma to show that following languages are not regular. **07**

$L = \{ 0^n 1^{2n} / n > 0 \}$

$L = \{ ww^R / w \varepsilon \{0,1\}^* \}$

OR

Q.3 **(a)** Convert NFA-^ to NFA and FA. Initial State: A , Final State: E **08**

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

(b) Find CFG from given PDA that accepts the language $\{0^n1^n\}$. PDA is (Q, Σ, Γ, δ, q, Z, F) where Q={q, r}, Σ = {0, 1}, Γ = {Z, X}, δ is defined by: **06**

State	Input	Stack	New State	Stack
q	0	Z	q	XZ
q	0	X	q	XX
q	1	X	r	^
r	1	X	r	^
r	^	Z	r	^

Q.4 **(a)** (1) Given the Context Free Grammar G, find a CFG G' in Chomsky Normal Form generating L(G) – { } **05**

$S \rightarrow SS \mid A \mid B$
$A \rightarrow SS \mid AS \mid a$
$B \rightarrow \wedge$

(2) Convert following CFG to PDA **02**

$S \rightarrow 0S1 \mid 00 \mid 11$

(b) For the language L={set of strings over alphabet {a, b} with exactly twice as many a's as b's} design a PDA (Push Down Automata) and trace it for the sring "abaabbaaaaabaab" **07**

OR

Q.4 **(a)** Given the Context Free Grammar G, find a CFG G' in Chomsky Normal Form generating L(G) – { } **07**

1) $S \rightarrow aY \mid Ybb \mid Y$
   $X \rightarrow \wedge \mid a$
   $Y \rightarrow aXY \mid bb \mid XXa$

2) $S \rightarrow AA$
   $A \rightarrow B \mid BB$
   $B \rightarrow abB \mid b \mid bb$

(b) For the language L={ $a^ib^jc^k$ | i, j, k ≥ 0 and i + j = k } design a PDA (Push Down Automata) and trace it for String "bbbbbccccc" **07**

Q.5 **(a)** Design Turing Machine(TM) to accept Palindrome over {a,b}, even as well as odd. **08**

(b) Write Short Note on Following: **06**

(i) Universal TM
(ii) NP-Hard and NP-Complete Language

OR

Q.5 **(a)** Draw Turing Machine(TM) which recognizes words of the form **08**
{ $a^nb^nc^n$ | n≥ 1 }

(b) Write Short note on Following: **06**

(i) Halting Problem
(ii) Church Turing Thesis

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