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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2018

Subject Code:2160704 **Date:03/05/2018**

Subject Name:Theory of Computation

Time:10:30 AM to 01:00 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)** Show that the CFG with productions **03**

S → a | Sa | bSS | SSb | SbS

is ambiguous.

(b) Define onto function. In each case, a relation on the set {1, 2, 3} is given. Of the three properties, reflexivity, symmetry, and transitivity, determine which ones the relation has. Give reasons. **04**

a. R = {(1, 3), (3, 1), (2, 2)}
b. R = {(1, 1), (2, 2), (3, 3), (1, 2)}
c. R = ϕ

(c) Write Principle of Mathematical Induction. Prove that for every n ≥ 1, **07**

$$\sum_{i=1}^{n} \frac{1}{i(i+1)} = n / (n + 1)$$

Q.2 **(a)** Explain Chomsky Hierarchy. **03**

(b) Convert the given Moore machine into Mealy machine. Draw state transition diagram of Mealy machine. **04**

Present State	Next State		Output
	0	1	
→p_0	r	q_0	ε
p_1	r	q_0	1
q_0	p_1	s_0	0
q_1	p_1	s_0	1
r	q_1	p_1	0
s_0	s_1	r	0
s_1	s_1	r	1

(c) Given the context-free grammar G, find a CFG G' in Chomsky Normal Form. **07**

G : S → AaA | CA | BaB
A → aaBa | CDA | aa | DC
B → bB | bAB | bb | aS
C → Ca | bC | D
D → bD | ε

ε represents null.

OR

(c) Define Context Free Grammar. Find context-free grammar for the language: L = $\{a^i b^j \mid i < 2j\}$ **07**

Q.3 **(a)** Show that the function f(x, y) = x + y is primitive recursive. **03**

(b) Explain Union Rule and Concatenation Rule for Context-Free Grammar. **04**

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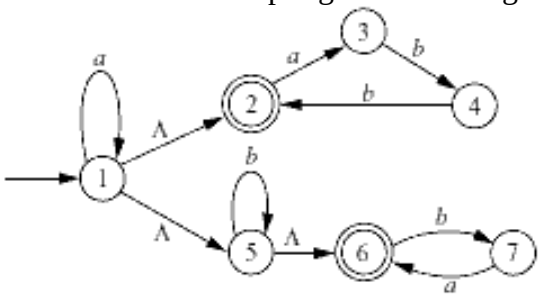
(c) Figure shows NFA-^. Draw an FA accepting the same language. **07**



OR

Q.3 **(a)** Define Constant functions, Successor functions and Projection function. **03**

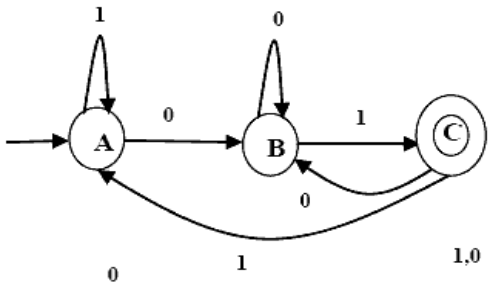
(b) Let G be the grammar **04**

S → aB | bA
A → a | aS | bAA
B → b | bS | aBB

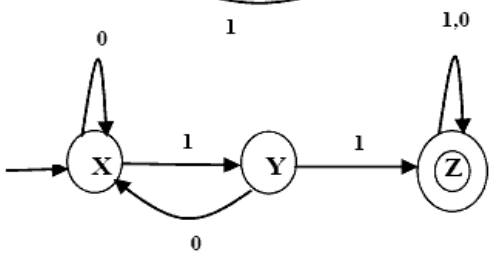
For string aaabbabbba, find Left most derivation and Right most derivation.

(c) Let M_1, M_2 and M_3 be the FAs pictured in Figure, recognizing languages L_1, L_2 and L_3, respectively. **07**

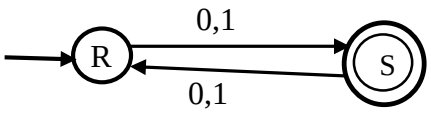
M_1 =



M_2 =



M3 =



Draw FAs recognizing the following languages.

a. $L_1 \cup L_2$
b. $L_1 \cap L_3$

Q.4 **(a)** Decide whether the given language is a CFL, and prove your answer. **03**

$L = \{ xyx \mid x, y \in \{a, b\}^* \text{ and } |x| \geq 1\}$

(b) Construct PDA for **04**

S → 0AB
A → 1A | 1
B → 0B | 1A | 0

Trace the string 01011 using PDA.

(c) Give transition tables for deterministic PDA recognizing following language: **07**

$L = \{x \in \{a, b\}^* \mid n_a(x) \neq n_b(x)\}$

Trace it for the string abbaababbb

OR

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Q.4 **(a)** Show using pumping lemma that the given language is not a CFL. **03**

$L = \{ a^n b^{2n} a^n \mid n \geq 0 \}$

(b) Prove that There are CFLs L_1 and L_2 so that $L_1 \cap L_2$ is not a CFL, and there is a CFL L so that L' is not a CFL. **04**

(c) For the PDA, $(\{q_0, q_1\}, \{0, 1\}, \{0, 1, z_0\}, \delta, q_0, z_0, \phi)$, **07**
where δ is

$\delta(q_0, \varepsilon, z_0) = \{(q_1, \varepsilon)\}$
$\delta(q_0, 0, z_0) = \{(q_0, 0z_0)\}$
$\delta(q_0, 0, 0) = \{(q_0, 00)\}$
$\delta(q_0, 1, 0) = \{(q_0, 10)\}$
$\delta(q_0, 1, 1) = \{(q_0, 11)\}$
$\delta(q_0, 0, 1) = \{(q_1, \varepsilon)\}$
$\delta(q_1, 0, 1) = \{(q_1, \varepsilon)\}$
$\delta(q_1, 0, 0) = \{(q_1, \varepsilon)\}$
$\delta(q_1, \varepsilon, z_0) = \{(q_1, \varepsilon)\}$

Obtain CFG accepted by the above PDA.

Q.5 **(a)** Find a regular expression corresponding to each of the following subsets of $\{0, 1\}^*$ **03**

1. The language of all strings that begin or end with 00 or 11.
2. The language of all strings containing both 11 and 010 as substrings.

(b) Define Context-Sensitive Grammar. Write a CSG for $\{a^n b^n c^n \mid n \geq 1\}$. **04**

(c) Draw a transition diagram for a Turing machine for the language of all palindromes over {a, b}. **07**

OR

Q.5 **(a)** Use the pumping lemma to show that following language is not regular. **03**

$L = \{xy \mid x, y \in \{0, 1\}^* \text{ and } y \text{ is either } x \text{ or } x^r\}$

(b) Write Short note on Church-Turing Thesis. **04**

(c) Draw a transition diagram for a Turing machine accepting the language $\{SS \mid S \in \{a, b\}^*\}$. **07**

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