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 **04**
three properties, reflexivity, symmetry, and transitivity, determine which ones the
relation has. Give reasons.
     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 **04**
diagram of Mealy machine.

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
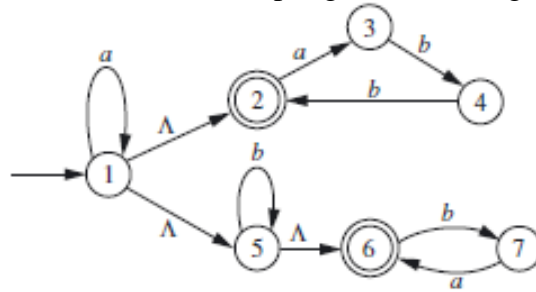   ε represents null.

OR

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

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**

(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 **07** and L_3, respectively.
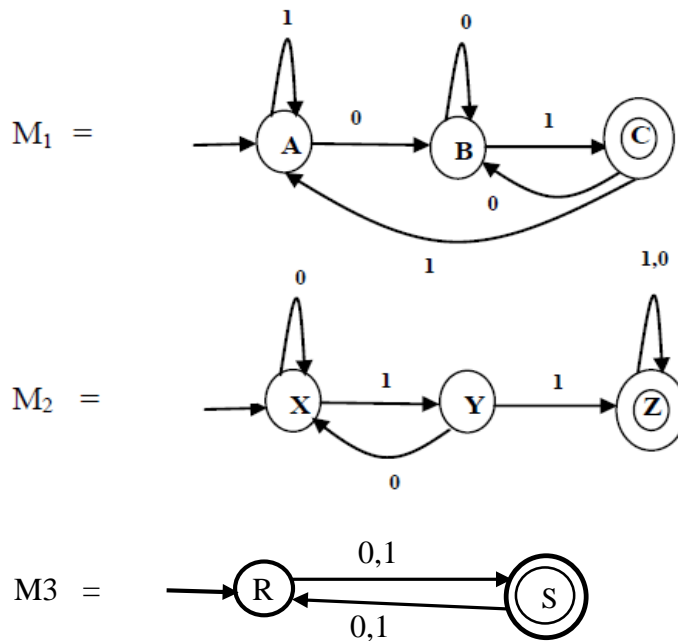
Draw FAs recognizing the following languages.
  a. $L_1 \cup L_2$
  b. $L_1 \cap L_3$

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

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 **04** CFL L so that L' is not a CFL.

(c) For the PDA, ($\{q_0, q_1\}$, $\{0, 1\}$, $\{0, 1, z_0\}$, δ, q_0, z_0, ϕ), **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 $\{0,$ **03** $1\}*$
  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 **07** palindromes over $\{a, b\}$.

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 $\{SS$ **07** $\mid S \in \{a, b\}*\}$.

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