**Seat No.: _____** **Enrolment No._____**

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2017**

**Subject Code: 2160704** **Date: 03/05/2017**

**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.**
4. **In the questions the symbol Λ denotes the null string, i.e., the string of length zero.**

**MARKS**

**Q.1** **Answer the following questions:**

**1** Define onto and one-to-one functions. **02**

**2** Give recursive definition of a tree. **03**

**3** Define reflexivity, symmetry, and transitivity properties of relations. **03**

**4** Consider the relation R = {(1,2), (1,1), (2,1), (2,2), (3,2), (3,3)} defined over {1, 2, 3}. Is it reflexive? Symmetric? Transitive? Justify each of your answers. **03**

**5** Draw truth table for following logic formula: P → (¬P V ¬Q). Is it a tautology? A contradiction? Or neither? Justify your answer. **03**

**Q.2** **(a)** Define DFA and NFA and NFA- Λ **03**

**(b)** Give recursive definitions of the extended transition functions, $\hat{\delta}$ (i.e., for strings) for DFA and NFA. **04**

**(c)** Minimize the DFA shown in Fig. 1. **07**

**OR**

**(c)** Consider the NFA-Λ depicted in following table: **07**

| | Λ | a | b | c |
|---|---|---|---|---|
| →p | Φ | {p} | {q} | {r} |
| q | {p} | {q} | {r} | Φ |
| * r | {q} | {r} | Φ | {p} |

(i) Compute the Λ-closure of each state.

(ii) Convert the NFA-Λ to a DFA.

**Q.3** **(a)** Explain 'finite state machines with outputs'. Discriminate between Mealy and Moore machines. **03**

**(b)** Convert the Moore machine shown in Fig. 2 into an equivalent Mealy machine. **04**

**(c)** Use Pumping Lemma to show that L = {x Є $\{0,1\}^*$ | x is a palindrome} is not a regular language. **07**

**OR**

**Q.3** **(a)** Give recursive definition of regular expressions. State the hierarchy of the operators used in regular expressions. **03**

**(b)** Using constructive approach determine NFA- Λ for the regular expression (0 + 1)*1(0 + 1). **04**

**(c)** Fig. 3 shows two DFAs M1 and M2, to accept languages $L_1$ and $L_2$, respectively. Determine DFAs to recognize $L_1$ U $L_2$. **07**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Give formal definition of PDA. Give mathematical description of 'acceptance of a string by a PDA by empty stack'. | **03** |
| | **(b)** | Give the recursive definition of the iterated derivation (i.e., derivation in zero or more steps), denoted as $=>^*$. Give mathematical description of the language of a CFG. | **04** |
| | **(c)** | Consider following grammar:<br>S → A1B<br>A → 0A \| Λ<br>B → 0B \| 1B \| Λ<br>Give leftmost and rightmost derivations of the string 00101. Also draw the parse tree corresponding to this string. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Define CFG. When is a CFG called an 'ambiguous CFG'? | **03** |
| | **(b)** | Consider following grammar:<br>S → ASB \| Λ<br>A → aAS \| a<br>B → SbS \| A \| bb<br>i. Eliminate useless symbols, if any.<br>ii. Eliminate Λ productions. | **04** |
| | **(c)** | Convert the following grammar to a PDA:<br>I → a \| b \| Ia \| Ib \| I0 \| I1<br>E → I \| E * E \| E + E \| (E) | **07** |
| **Q.5** | **(a)** | Give definition of Turing Machine. What do you mean by an instantaneous description of a Turing Machine? | **03** |
| | **(b)** | Describe recursive languages and recursively enumerable languages. | **04** |
| | **(c)** | Design a Turing machine to accept the language $\{0^n1^n \mid n \geq 1\}$. | **07** |
| | | **OR** | |
| **Q.5** | **(a)** | Briefly describe following terms: (1) halting problem (2) undecidable problem | **03** |
| | **(b)** | Using pumping lemma for CFL's, show that the language $L = \{a^m b^m c^n \mid m \leq n \leq 2m\}$ is not context free. | **04** |
| | **(c)** | Design a Turing machine for the language over {0,1} containing strings with equal number of 0's and 1's. | **07** |

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**Figures**

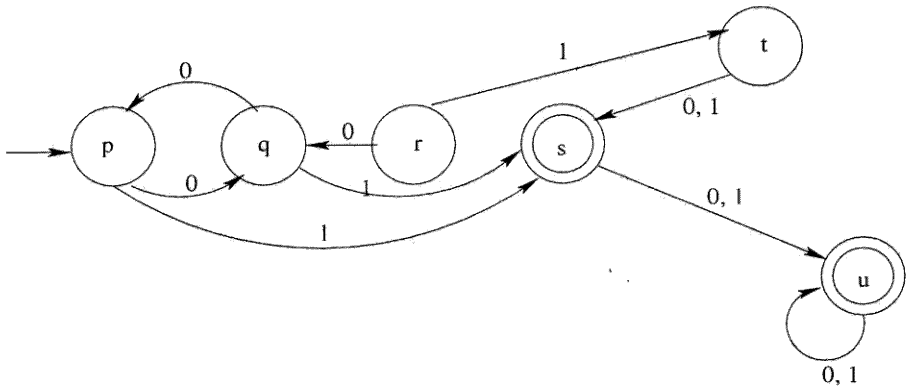


Fig. 1 for Q 2 (c)

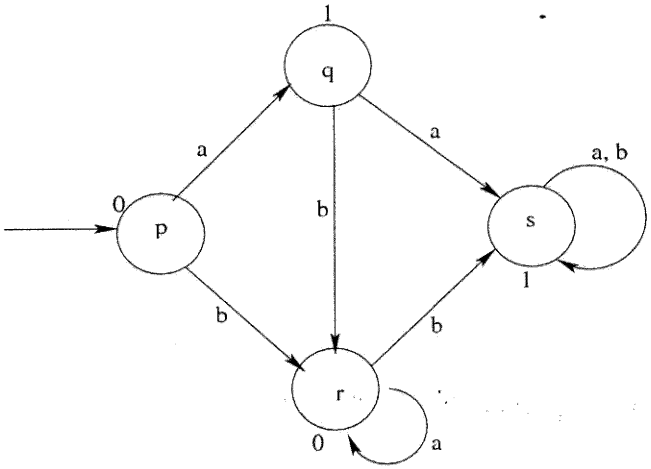


Fig. 2 for Q 3 (b)

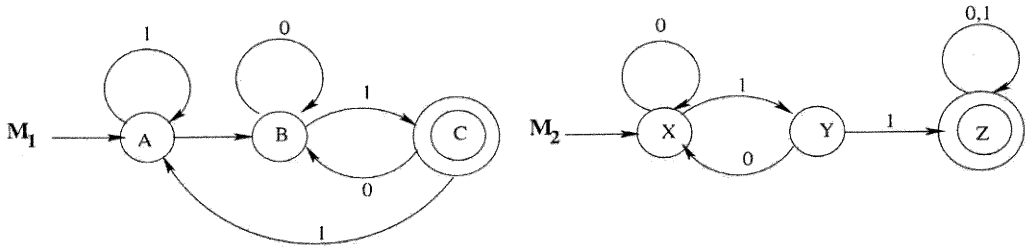


Fig. 3 for Q 3 (c) (OR)

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**Note: In Fig.3 for Q:3 (c) consider transition from A -> B having symbol 0.**