Fast**National University of Computer & Emerging Sciences, Karachi  
Spring-2018 CS-Department  
Final Exam  
22nd of May 2018, 9:00 am – 12:00 noon**

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| **Course Code: CS301** | **Course Name: Theory of Automata** |
| **Instructors Name: M.Shahzad, Subhash Sagar and Shaharbano** | |
| **Student Roll No:** | |

**Instructions :**

* **Return the question paper.**
* **Read each question completely before answering it.**
* **In case of any ambiguity, you may make assumption, but your assumption should not contradict any statement in the question paper.**
* **Start each question on a new sheet.**
* **There are total 9 Questions on 2 Pages.**

**Time: 180 minutes. Max Marks : 120 points**

**Question 1: True** or **False (With Reasons) (5) Points**

1. **There is a regular language L for which there is exactly one regular expression R with L(R) = L.**
2. **Union of regular language with context free language is not always a regular language.**
3. **L4 = L1∩L2∩L3, where L1 and L2 are regular and L3 is CFL. It is possible that L4 will be a regular language.**
4. **L2 = Complement of L1, where L1 is a CFL. It is possible that L2 will be a regular language.**
5. **The language L ={ aibj|i≥j} is regular language.**

**Question 2: Regular exp. (R.E.) & FA’s (5+5+5+5+5) Points**

1. **Construct the FA for a language upon ∑ ={a,b,c} which accepts all strings not ending with "abc".**
2. **Construct the DFA A for strings accepting all 0's and odd 1's. State the R.E.**
3. **Construct the DFA B for strings accepting all 1's ending with odd 0's. State the R.E.**
4. **Concatenate the DFA's A and B to find DFA AB.**
5. **Take the union of A and B to find a DFA for A∪B.**

**Question 3: CFG (5+5+5) Points**

**Construct a CFG which generates the following languages:**

1. **L1 ={ anbn|n≥1}**
2. **L2 ={ anbman|n≥1}**
3. **Find L1L2 and L1**∪**L2**

**Question 4: Ambiguity in CFG (5) Points**

**Check whether the following grammar is ambiguous, take expression w=ibtibtaea**

**S → iCtS|iCtSeS C → b S → a**

**Question 5: CNF (5+5) Points**

**Consider the following CFG for non empty language:**

**S1 → S**

**S → aSb|BB|BCD |ab|BC**

**A → DD | B | BCB | D | ε**

**B → AB |C | ε**

**C → Cc|c**

1. **Simplify showing each steps clearly.**
2. **Convert the above CFG into CNF.**

**Question 6:** **P.D.A.** **(5+5+5) Points**

1. **Construct an equivalent P.D.A. from the following CFG:**

**S🡪 aTb| b**

**T🡪 Ta | ɛ**

1. **Trace the input sring "aaab" using stack.**
2. **Construct a P.D.A. accepting for the language L ={ a4bn cn|n≥0}**

**Question 7:**  **Turing Machines (TM)**  **(10+5+5) Points**

1. **Create Turing Machines for the following languages and function:** 
   1. **L2 ={a3nbnc2n|n≥2}.**
2. **Give an example of infinite loop resulting in Non-Halting TM.**
3. **Give formal definitions of a two-tape Turing machine for the language  *{w | wR = w is any string of 0’s and 1’s}.* [Hint: give some example]**

**Question 8: Undecidability & UMT (5+5+5) Points**

1. **Draw the Chomsky hierarchy of languages with the Venn diagram. Also label recursive, recursively enumerable, non recursively enumerable, decidable problems and undecidable problems in the drawn Venn diagram.**
2. **Define the following terms:**
3. **Recursive TM,**
4. **Recursively Enumerable TM,**
5. **Undecidable Problems.**
6. **Define Universal Turing Machine. Give an example of UTM.**

**Question 9: 8 (5+5) Points**

**Select and design the best machine for the following language:**

**L = { (anbncmdm| n=2,m=2) ∪ (anbmcmdn| n=2, m=1}**

**Justify your selection regarding its working, time cost and storage cost.**

***BEST OF LUCK!***