**National University of Computer and Emerging Sciences**

**(Islamabad Campus)**

Department of Computer Science

CS-301 Theory of Automata

Final Exam (Fall 2012)

**PART II**

**Instructor(s):**

Ms Mehreen Alam, Ms Ramoza Ahsan, Dr Waseem Shehzad

Dec 28, 2012

**Total Marks: 80 Time Allowed: 2 hours**

* Exam is divided into two parts. Part I is to be taken on SLATE.
* Examination is closed books/notes. No notes, cheat sheets, textbook, or printed material allowed.
* Make sure you have all the 3 Pages.
* Answer on the answer sheets, separately provided.
* If you believe that some essential piece of information is missing, make an appropriate assumption and use it to solve the problem.

**Roll No: \_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Section: \_\_\_\_\_\_\_\_\_\_\_**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
| Points | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 80 |
| Score |  |  |  |  |  |  |  |  |  |

Vetted By: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Vetter Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Write the regular expression and build an FA for the following languages :
   1. Every word has even number of substings ‘ab’.
   2. Every word ends with a double letter ‘aa’. (10)
2. Build a PDA that accepts the language L = axbyczazbycx, where x,y,z >0. (10)
3. Write a CFG to generate the language MOREA of all strings that have more a’s than b’s (not necessarily only one more but any number more a’s than b’s).

MOREA = {a,aa,aab,aba,baa,aaaa,aaab,….} (10)

1. Build a Turing Machine for the language 3EQUAL which is defined over the alphabet E={a,b,c} as all the strings have as many total a’s as total b’s as total c’s**.**

3EQUAL = {abc, acb, bac, bca, cab, cba, aabbcc, aabcbc,…. } (10)

1. Design a Turing machine that takes input two numbers (x,y>0) and performs the **multiplication** operation on them. Input on the TM tape is in the form x0y. Use unary representation. For example, on input 110111 the output on the tape is 1111110. (10)
2. For the language **anb2ncn**, design a 2-stack PDA. (10)
3. Build a Post Machine that takes in any strings of a’s and b’s and exchanges the first and the last letters and then accepts. For example, on input abab and bbaa, the output left on the STORE is bbaa and abab respectively. (10)
4. Briefly answer for the following. (10)
   1. What is are recursively enumerable languages.
   2. Explain how non-determinstic TM has the same power as deterministic TM. (10)