CS 301 Theory of Automata

Serial No:

Final Exam Part II

Total Time: 2 Hours
Total Marks: 100 (Part II)

Monday, Jan 08, 2017

Course Instructor

Dr Waseem Shehzad, Dr Labiba Fahad and Ms. Mehreen Alam

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Signature of Invigilator

Student Name ____________ Roll No ________ Section ______ Signature ____________

DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

Instructions:

1. This is Part II, the design part of the exam.
2. Attempt all of them. Read the question carefully, understand the question, and then attempt it.
3. No additional sheet will be provided for rough work. Use the back of the last page for rough work.
4. After asked to commence the exam, please verify that you have **fourteen (14)** different printed pages including this title page. There are total of **10 questions**.
5. Use permanent ink pens only. Any part done using soft pencil will not be marked and cannot be claimed for rechecking.

	1	2	3	4	5	6	7	8	9	10	**Total**
Total Marks	10	10	10	10	10	10	10	10	10	10	**100**
Marks Obtained											

Vetted By: ____________________________ **Vetter Signature:** ____________________

Q1. **[5+5 =10 pts]** Write regular expression for the following languages defined over ∑ = {a,b} where:

1. no word ends on **bb**

2. no word contains the substring **ab**

Q2. **[5+5 =10 pts]** Construct a Context Free grammar over ∑ = {a,b} whose language is:

1. LESSA where all strings have less a's than b's

   LESSA = {abb,aabbb,aabbb,babab,bbaba,babababbab,bbbbabaab,….}

2. Every word has odd number of substrings 'ab'.

Q3. **[10 pts]** Convert the following grammar to Chomsky Normal Form Grammar. Show all the intermediary steps in the correct order clearly to score full marks.

S → aAbB | ABC | a
A → aA | a | CD
B → CbC | b
C → CC | Δ
D → CC | Db
E → EE | Δ

Q4. **[10 pts]** Convert the following grammar to its equivalent Greibach Normal Form.

S → ab|a
A → SS|b

Q5. **[10 pts]** Use Pumping Lemma to prove that the following language is not Context-Free

$$\mathbf{A = \{ 0^n 1^m 0^n 1^{2n} \mid n,m,k > 0 \}}$$

Q6. **[10 pts]** Design a PDA for **ODD PALINDROME = { a, b, aaa, aba, bab, bbb, aaaaa, … }**

Q7. **[10 pts]** Design a Post Machine for the language $\mathbf{a^{2n}b^{n}a^{n}}$ for $n \geq 0$.

Q8. **[10 pts]** For the language $\mathbf{a^{2n}b^{n}c^{2n}d^{n}}$, where $n \geq 0$, design a 2-PDA.

Q9. **[10 pts]** Let L be some regular language in which all the words happen to have an even length. Let us define the new language Twist(L) to be the set of all the words of L twisted, where by twisted we mean the first and second letters have been interchanged, and so on. For example, if

L = { ba abba babb ……}

Twist(L) = { ab baab abbb ……}

Build a Turing Machine that accepts Twist(L). You are also **allowed** to use the sub programs of **INSERT** and **DELETE**. You may assume after **INSERT** operation, tape head points at the newly added cell while after **DELETE** operation, tape head points at the same location. You may leave the tape head at any location on the output string when the computation is done.

Status of tape on input is:

#	a	b	b	b	a	b	a	a	Δ	Δ	Δ	.	.
	↑												

Status of tape at the output is:

#	b	a	b	b	b	a	a	a	Δ	Δ	Δ	.	.
							↑						

Q10. **[10 pts]** Design a Turing machine that takes input a non-negative number x and performs the computable function **f(x) = 4x**. Assume the input is in unary notation, the tape head points in the start of the input. However, you may leave the tape head at any location on the output string when the computation is done. You are also **allowed** to use the sub programs of **INSERT** and **DELETE**. You may assume after **INSERT** operation, tape head points at the newly added cell while after **DELETE** operation, tape head points at the same location. An example is given below for your understanding:

Status of tape on input is:

#	1	1	Δ	Δ	Δ	.	.	.
	↑							

Status of tape at the output is:

#	1	1	1	1	1	1	1	1	Δ	.
						↑				