National University of Computer & Emerging Sciences, Karachi

Fall-2018 CS-Department

Final Exam

26nd of December 2018, 9:00 am – 12:00 noon

Course Code: CS301	Course Name: Theory of Automata
Instructor Name:	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: **(5) Points**

For each of the following choose suitable machines.

a) **Regular Languages**
b) **Context Free Languages**
c) **WWR**
d) **WW**
e) **Functions**

Question 2: **(10+5+(5+5)) Points**

a) **Construct the DFA A5 for a language upon ∑ ={0,1,2,3,4,5,6,7,8,9} which accepts all strings divisible by 5 .**
b) **Using this DFA construct the DFA AN5 not accepting any strings divisible by 5. Are both DFA's compliment of each other?**
c) **Consider the homomorphism h from the alphabet {0,1,2} to {a,b} defined by : h(0)=ab, h(1)= b, h(2)= aa,**
    1. **what is h(0210)?**
    2. **if L is the language consisting single string ababb what is h^{-1}(L)**

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

Construct a CFG which generates the following languages:

a) **L1 ={ $a^i b^j$ | 2j≥i}**
b) **L2 ={ $a^n b^m c^p$| n=m+p}**

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

Give two parse trees of the expression w=abababa from the CFG

S → SbS|a

Decide if the CFG is ambiguous or not.

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

Consider the following CFG for non empty language:

$S \rightarrow ABC|BaB|$
$A \rightarrow aA \mid BaC \mid aaa$
$B \rightarrow bBb \mid a \mid D$
$C \rightarrow CA|AC$
$D \rightarrow \varepsilon$

a) Simplify showing each steps clearly with correct ordering.(kindly label your steps neatly)
b) Convert the above CFG into CNF.

Question 6: P.D.A. **(5+10) Points**

a) Construct an equivalent P.D.A. by empty stack, from following CFG:
   $S \rightarrow 0TT$
   $T \rightarrow 0S|1S|0$
b) Construct a P.D.A. accepting for the language L ={ $a^i b^j c^k$| i=j or j=k}

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

a) Create Turing Machines for the following language and function:
   i. $L_2 = \{0^n1^m0^n1^m \mid n,m \geq 1\}$.
      Show the ID of your TM if the input tape contains 001001.
   ii. $f(x,y) = \begin{cases} x+y & x < y \\ x-y & x > y \end{cases}$ else write "equal" on the tape if x = y.
b) Give an example of infinite loop resulting in Non-Halting TM. Will the TM result in Recursive TM or Recursively Enumerable TM.

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

a) 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.
b) Define Recursive TM, Recursively Enumerable TM, Undecidable Problems.
c) If L is a Recursively Enumerable language, is the complement of L Recursively Enumerable? Support your answer.

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

Design a machine for the following

$L = \{ (ww \mid w = \text{"welldone"}) \cup (ss^r \mid s = \text{"mom"}\}$

Argue your machine is best in working regarding Time cost and storage cost.

BEST OF LUCK!