Department of Computer Science & IT

The Islamia University of Bahawalpur

MCS –3rd (Morning) | **Subject: Theory of Automata and Formal Languages (CSIT-21304)**
Final term – 19 Jan. 2017 | **Time: 1 hr. 50 min.**
Instructor: Dr. Nadeem Akhtar | **(Marks: 50)**

Q1. Short questions

a) **Formally define a Context-Free Grammar. Give an example.**

b) **Differentiate between Regular Language and Context-Free Language. Give one example of each.**

c) **Write CFG for the language: $\{0^n@1^n \mid n \geq 0\} \cup \{1^n@0^n \mid n \geq 0\}$**

d) **Consider the following Context-Free Grammar**

<EXPR) → <EXPR> + <TERM> | <TERM>
<TERM> → <TERM> x <FACTOR> | <FACTOR>
<FACTOR> → (<EXPR>) | a

Formally describe the above grammar. Using the above grammar construct parse trees of the following expression:

a x a + (a + a + a)

(5 + 5 + 5 + 5 = 20)

Q2. Describe the languages denoted by the following Regular expressions:
(Note: The alphabet $\sum = \{0, 1\}$)

a) **000 $(\sum\sum)^*0$**

b) **$1^*(01^+)^*$**

c) **$1(\sum\sum\sum)^+0$**

d) **$0\sum^*0 \cup 1\sum^*1 \cup 0 \cup 1$**

(2.5 + 2.5 + 2.5 + 2.5 = 10)

Q3. Consider the language:

$$\{1^n0^n \mid n \geq 0\}$$

a) **Construct a Push-Down Automata that recognizes the above language.**

b) **Formally describe the constructed Push-Down Automata.**

(5 + 5 = 10)

Q4. a) **Define a Turing Machine. Define Turing-Recognizable and Turing-Decidable languages.**

b) **Consider $\Gamma = \{a, b, c\}$, $\Gamma^* = \{u, v\}$ and states are q_i , q_j and q_k**

Write the transition functions that handles the following Turing Machine configurations:

i. $ua\ q_i\ bv$ **yields** $u\ q_j\ acv$

ii. $ub\ q_i\ av$ **yields** $ubc\ q_j\ v$

iii. $uc\ q_j\ av$ **yields** $u\ q_k\ cb\ v$

(5 + 5 = 10)