Ph.D. Comprehensive Examination

Computer Science Department
University of Miami

August 16, 2019

Student Name: Student Number:

Problem number	Points (10 max)
1	
2	
3	
4	
5	
Total:	

1. **I.A Data organization; III.A Algorithms and complexity**

   Each item x in a set S has a unique key $key[x]$. We need to implement the following operations.

   (a) Search (S, key)
   (b) Insert (S, x)
   (c) Successor (S, x)
   (d) Predecessor (S, x)

   Give the 4 running times as an O() for the following implementations:

   (a) Ordered (sorted) array,
   (b) Ordered doubly linked list,
   (c) Min-Heap, and
   (d) Hash table

2. **I.D Software engineering**

   From the software engineering point of view, any software development process can be divided into several sub-disciplines:

   (a) Requirement Analysis

   (b) Functional Specification

   (c) Architectural Design

   (d) Implementation

   (e) Testing and Evaluation

   (f) Maintenance

   Choose three sub-disciplines or tasks within these sub-disciplines that involve a mathematical approach, and illustrative them with examples.

3. **II Computer Organization**

   (a) Draw an architecture of a quad-core processor and discuss the role of each module in your diagram.

   (b) Find a binary representation of the decimal number 0.1.

4. **Automata and language theory**

   Consider the following grammar:

   $G \longrightarrow S\ \$\$$
   $S \longrightarrow A\ M$
   $M \longrightarrow S \mid \epsilon$
   $A \longrightarrow a\ E \mid b\ A\ A$
   $E \longrightarrow a\ B \mid b\ A \mid \epsilon$
   $B \longrightarrow b\ E \mid a\ B\ B$

   (a) Describe the language that the grammar generates in English.

   (b) Show a parse tree for the string `a b a a`.

   (c) Is the grammar LL(1)? If so, show the parse table; if not, identify a prediction conflict.

5. **III.C Discrete Structures**

   Recall that the Hamiltonian Cycle Problem is the problem of deciding, on input graph G, whether G has a cycle that visits all the nodes exactly once. Show that this problem is polynomial time decidable if the input is restricted to the graphs with the property that each node has at most two neighbors (i.e., at most two adjacent nodes).