

# Ph.D. Comprehensive Examination

Computer Science Department  
University of Miami

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Student Name:

Student Number:

Problem number	Points (10 max)
1	
2	
Total:	

**1. III.A Algorithms and complexity**

Describe an algorithm that takes two input lists of integers  $A = a_1, \dots, a_n$  and  $B = b_1, \dots, b_m$  and delivers the list of all the elements that belong to  $A$  but not to  $B$ .  $A$  and  $B$  do not contain redundant elements, however, the elements of  $A$  and  $B$  might have a large range.

The algorithm should run in  $O(n \log m + m \log m)$  time.

**2. 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.