

This exam has 4 questions, for a total of 20 points. You have 2.5 hours to complete the exam. Please read carefully the guidelines below:

- Your submission to Gradescope must include the following files:
  1. A text file named **XXXX.txt**, where **XXXX** are the last four digits of your **student ID**. This file is the most important as it will be used for **grading** your work. This file must contain your final answers to all questions, one per line. If you don't have an answer, you can leave the line empty. A template is provided at: <https://homepage.cs.uri.edu/~malvarez/stationary/exam/ans.txt>.
  2. A PDF file named **XXXX.pdf**, where **XXXX** are the last four digits of your **student ID**. This file will contain your work. You can write your solutions on your own paper(s) and then scan or photograph them into a single PDF. Do not worry about alignment or format, as long as your work is readable. In this file, your work on each question can be in any order.
- If the question is multiple choice, the answer **must be** the corresponding letter (A, B, C, ...). If the question is open, the answer will be a single number, or as otherwise specified in the question.
- You may use any of our lecture notes, books, or additional written/online references. However, when solving the questions, your solution must follow the algorithms and formulas introduced in our lectures.

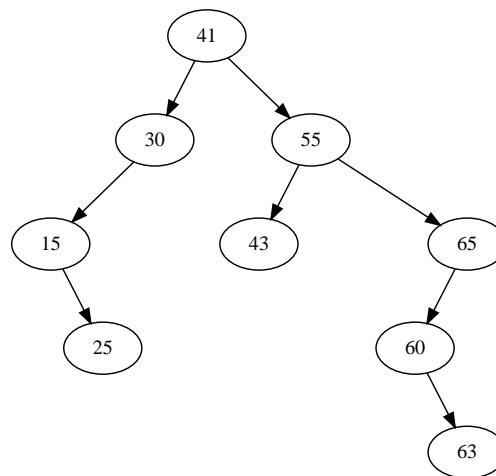
By submitting my solutions to this exam I acknowledge that I have read and understood the guidelines above, that all answers are my own, and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage.

1. (5 points) Indicate the sum of the values corresponding to all statements that are **True**. Mark 0 if none are **True**:

- (1) The best-case performance of finding the smallest element in a BST is  $\Theta(1)$
- (2) A binary heap is a complete BST
- (4) Any complete tree can be efficiently represented as an array
- (8) The worst-case performance of finding the largest element of a BST is  $\Theta(1)$

1. \_\_\_\_\_

2. (5 points) Considering the BST below:



What is the output of a preorder traversal that, for each visit, prints the *height* of the node?

- A. 4, 3, 2, 1, 0, 1, 0, 3, 2, 1, 0
- B. None of the others
- C. 4, 3, 2, 1, 0, 2, 0, 3, 2, 1, 0
- D. 4, 3, 2, 2, 2, 1, 4, 3, 2, 1, 0
- E. 4, 3, 2, 3, 1, 1, 4, 3, 2, 1, 0

2. \_\_\_\_\_

3. (5 points) Indicate the sum of the values corresponding to all statements that are **True**. Mark 0 if none are **True**:

- (1)  $2^h$  is the minimum number of nodes in a binary heap of height  $h$
- (2) In a max-heap each key is greater or equal to the keys of all ancestors
- (4) Traversing a BST using *pre-order* results in a sorted list of keys
- (8) A binary heap is a complete binary tree

3. \_\_\_\_\_

4. (5 points) A post-order traversal of a *max-heap* with 7 elements is  $1, 2, \dots, 6, 7$ . What is the sum of all nodes of height  $h = 2$ ?

4. \_\_\_\_\_