

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.

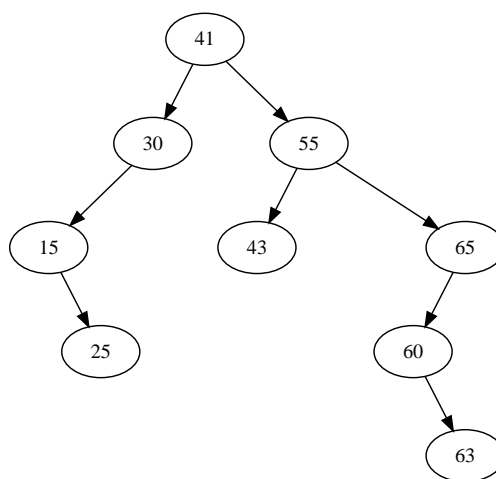
1. (5 points) Consider an empty hash table of length 11, in which keys 17, 22, 1, 32, 23, 41, 9, 28 are inserted with $h(x) = (x+5) \bmod 11$ and separate chaining. What is the total number of *collisions*?

1. _____

2. (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 $h = 1$?

2. _____

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

3. _____

4. (5 points) Indicate the sum of the values corresponding to all statements that are **True**. Mark 0 if none are **True**:

- (1) Traversing a BST using *pre-order* results in a sorted list of keys

- (2) The worst-case performance of finding the largest element of a BST is $\Theta(1)$
- (4) A binary heap is a complete BST
- (8) 2^h is the minimum number of nodes in a binary heap of height h

4. _____