This exam has 5 questions, for a total of 25 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.

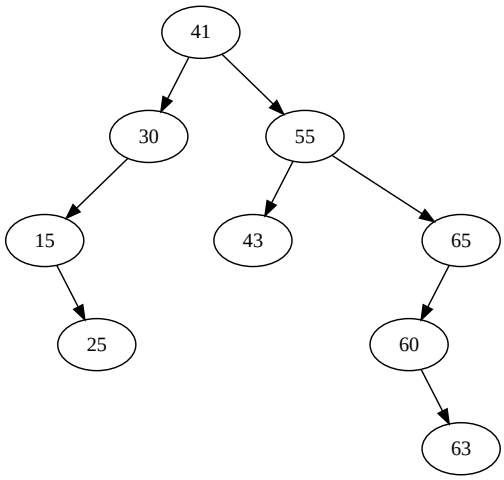
1. (5 points) Consider an empty hash table of length 11, in which keys $17, 22, 11, 36, 28, 41, 19, 30$ are inserted with $h(x) = (x+5) \mod 11$ and separate chaining. What is the total number of *collisions*?

1. _____

2. (5 points) A post-order traversal of a *max-heap* with 7 elements is $1, 2, \ldots, 6, 7$. What is the sum of all keys in 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, 2, 1, 0, 3, 0, 2, 1, 0

C. 4, 2, 1, 1, 3, 0, 2, 1, 0

D. 3, 2, 3, 2, 1, 4, 2, 1, 0

E. 4, 2, 1, 0, 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. _____

5. (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) Any complete tree can be efficiently represented as an array

(4) A binary heap is a complete binary tree

(8) In a max-heap each key is greater or equal to the keys of all ancestors

5. _____