1. Give and briefly explain an example of a solution that uses recursion.

2. Define:
   a. Tree
   b. Interior node
   c. Binary tree
   d. Complete binary tree
   e. Balanced binary tree
   f. Leaf node
   g. AVL tree
   h. BST

3. For a given general tree, what characteristic of the tree gives the maximum number of steps required to find any particular node? What about for a Balanced BST?

4. Given 5 unique elements to store in a binary tree:
   a. What is the worst case for the height of the tree after adding all the elements?
   b. What is the best case for the height of the tree after adding all the elements?
   c. With a BST and input in sorted order, what is the expected height of the tree after adding all the elements?

5. What is the expected time complexity for a merge sort?

6. Write the pseudo code to do a breadth-first traversal of a binary tree.

7. Write the pseudo code to do a pre-order traversal of a binary tree.

8. Give an example, other than searching, of a use for a depth-first traversal of a binary tree.

9. Given the following in-order traverse and pre-order traverse draw the BST that results from it:
   a. In-order: 1, 2, 3, 4, 5, 6, 7, 8, 9
   b. Pre-order: 5, 1, 3, 2, 4, 7, 6, 9, 8
   c. Who are the left and right children of 2?
   d. Is the resulting tree complete?
   e. Is the resulting tree full?
   f. Is the resulting tree balanced?
10. Build BSTs out of the following sequences:
   a. 1, 2, 3, 4, 5. Is the resulting BST balanced? Is it complete? Is it full?
   b. 3, 20, 0, 25, 7, 1. Is the resulting BST balanced? Is it complete? Is it full?
   c. 7, 10, 5, 1, 9, 11, 6. Is the resulting BST balanced? Is it complete? Is it full?
11. Build a minheap out of the following sequence: 8, 6, 0, 1, 4, 17, 3, 21.
12. In class, we discussed an AVL tree to produce a balanced BST:
   a. Does it always produce a perfectly balanced tree?
   b. What does it do to achieve balance?
   c. After the tree is balanced, does it preserve the property of being a BST?
   d. What did the structure add to each node to aid in the balancing?
13. Build the graph resulting from the following adjacency matrix and answer the following questions:
   a. Is the graph directed, undirected, or weighted?
   b. Is there a cycle in this graph?
   c. Is the graph complete?
   d. Is the graph connected?
   e. Give the set of vertices and the set of edges for this graph

\[
\begin{array}{c|ccc}
\text{0} & \text{1} & \text{2} & \text{3} \\
\hline
\text{0} & 0 & 1 & 0 & 1 \\
\text{1} & 0 & 0 & 1 & 0 \\
\text{2} & 1 & 1 & 0 & 0 \\
\text{3} & 0 & 0 & 0 & 0 \\
\end{array}
\]

\[G (V, E)\]
14. Knowing that a tree is a special case of graphs, and knowing that graphs can be directed or undirected, cyclic or acyclic, connected, and complete. Define a tree in terms of a graph.
15. Draw the undirected graph that is represented as follows
   Vertices: \{1, 2, 3, 4, 5, 6, 7\}
   Edges: \{(1, 2), (1, 4), (2, 3), (2, 4), (3, 7), (4, 7), (4, 6), (5, 6), (5, 7), (6, 7)\}
16. List all of the cycles you can find in the previous graph
17. Draw the hash table that results from adding the following integers (34 45 3 87 65 32 1 12 17) to a hash table using a table of size 11 and using the division method (as the hash function) and linked chaining.