

Assessment Exam
Data Structures/Discrete Math

Name _____ Date _____

1. The following questions refer to the universal set $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ and the sets

$$\begin{array}{lll} A = \{1, 2, 3, 4, 5\} & C = \{5, 6, 7, 8, 9\} & E = \{2, 4, 6, 8\} \\ B = \{4, 5, 6, 7\} & D = \{1, 3, 5, 7, 9\} & F = \{1, 5, 9\} \end{array}$$

- a) Give the union $A \cup B =$ _____
- b) Give the intersection $E \cap C =$ _____
- c) Give the complement $A^c =$ _____
- d) Give the set difference $D \setminus A =$ _____
- e) Give the power set of F

- f) Given the sets $S = \{a, b\}$ and $T = \{1, 2, 3\}$, find the Cartesian product $S \times T$.

2. Using induction prove: $1 + 4 + 7 + \dots + (3n - 2) = n(3n - 1)/2$.

3. Using a truth table, show that $p \vee \neg(p \wedge q)$ is a tautology.

4. Let $A = \{a, b\}$. Construct a finite automaton M which will accept precisely those words from A which have an even number of a 's. For example $aababbab$, aa , $ababaa$ will be accepted by M , but $ababa$, aaa , $bbabb$ will be rejected by M .

5. An algorithm that is $O(\log n)$ _____ (is/ is not) more efficient than an algorithm of $O(n \log n)$.

6. Name two operations other than *create* that an array ADT and a list ADT have in common.

7. What is the **major** difference between a stack and a queue?

8. What are the basic queue operations?

9. a) What is an advantage of an array implementation of a queue?

b) What is a disadvantage of an array implementation of a queue?

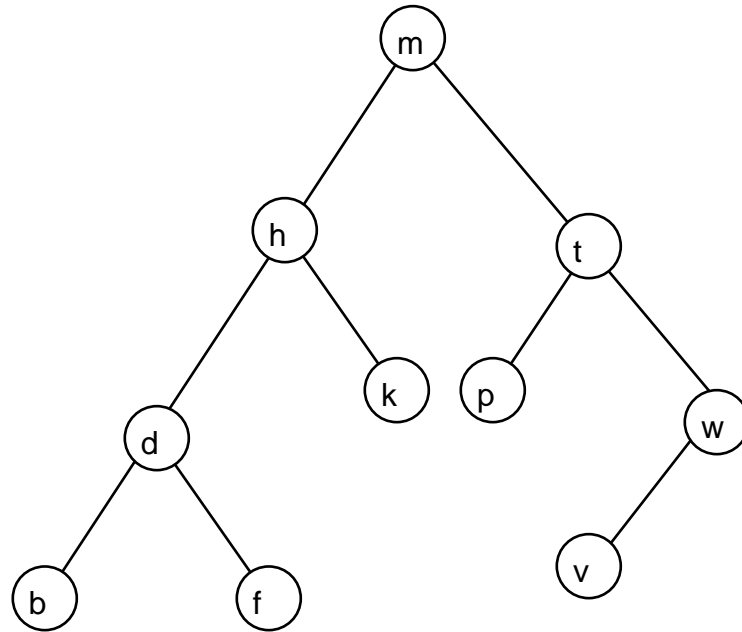
10. When deleting an existing node from a binary search tree, what cases must be considered?

11. Explain the difference in the *find* operation for a linked list and a binary search tree. (Discuss how it is done.)

12. Suppose that you have a hash table with 10 buckets, integer key values, and use the hash function $f(x) = x \bmod 10$ with linear probing. Show the hash table after inserting EACH of the following key values in the given order:

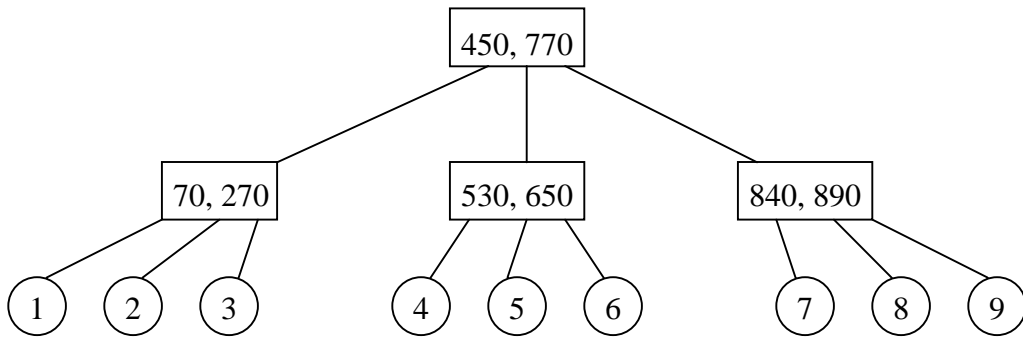
75, 66, 42, 192, 91, 40, 49, 87, 67, 16.

13. a) The preorder traversal of the following tree is _____
- b) The postorder traversal of the following tree is _____
- c) The inorder traversal of the following tree is _____



14. A merge operation takes two linked lists that are sorted in ascending order and creates a third (or new list) that contains all of the data from each list still in sorted order. For example: suppose ListOne = <1, 3, 5, 6> and ListTwo = <2, 4, 7, 8, 9>, then the merge operation would generate a new list that looks like ListThree = <1,2,3,4,5,6,7,8,9>. Write pseudo code for a function called Merge that takes as parameters the two lists and returns the new merged lists. Assume that the lists are singly linked. *Hint:* draw pictures to check your pseudo code.

15. Given the following B-tree, which leaf node (numbered circle) contains each of the keys listed? (Give the number of the leaf in which you would locate the key.)



<u>KEY</u>	<u>LEAF NUMBER</u>
30	_____
275	_____
550	_____
940	_____
800	_____

16. Give the pseudocode for a bubble sort algorithm to sort an array of n items into ascending order.

17. Some sorting algorithms do direct sorting by moving the data as it is sorted (for example bubble sort); others do indirect sorting using pointers (for example, an in-place sort).

a) what is an advantage of a direct sort over an indirect sort?

b) in what case would an indirect sort be preferable to a direct sort?

18. Given a doubly linked, circular, sorted list; write the pseudocode for inserting a new node into the list in its proper place.

19. What do quicksort and binary search algorithms have in common?

20. Why are so many of the binary search tree operations implemented as recursive functions?