



April 19, 2016

Part 1: Multiple-Choice Questions

For each 4-choice question, take only one choice as the correct answer. For each of your wrong answer, a **penalty of 4 points** will be deducted from your overall score.

1. (4 pts) Consider a linked list of n elements. What is the time taken to insert a new element after an element pointed by some pointer?
- (A) $O(1)$ (B) $O(\log n)$
(C) $O(n)$ (D) $O(n \log n)$
2. (4 pts) The process of accessing data stored in a serial/sequential access storage (like magnetic tape) is similar to manipulating data on a:
- (A) linked list (B) stack
(C) queue (D) heap
3. (4 pts) Which of the following operations is performed more efficiently by a doubly-linked list than by a singly-linked list?
- (A) Searching of an unsorted list for a given item
(B) Inverting a node after the node whose location is given
(C) Traversing a list to process each node
(D) Deleting a node whose location is given
4. (4 pts) If a node in a BST (Binary Search Tree) has two children, then its in-order predecessor has:
- (A) no left child (B) no right child
(C) two children (D) no child
5. (4 pts) A mirror image of a binary tree is another binary tree with left and right children of all non-terminal nodes interchanged. What traversal algorithm can be used to convert a binary tree into its mirror image?
- (A) Pre-order (B) In-order
(C) Post-order (D) Any order

Part-2: Descriptive Questions

6. (20 pts) Now we will show how a given array [5, 7, 2, 9, 3, 8, 6, 1] can be sorted in descending order, using Heap Sort which is executed according to the following steps. We know that the given array is a complete binary tree for the elements to sort.
- (a) (10 pts) *Heapify* the complete binary tree into a max-heap and show the result in a form of an array diagram like [x, y, z, ...]
- (b) (10 pts) Perform *DeleteMax* operations until the *max-heap* becomes empty, and draw an array diagram of the *max-heap* after each removal.
7. (10 pts) For any node in a BST, the smallest key in its right-subtree must be in a leaf or degree 1 node. Prove it.
8. (15 pts) For a given postfix expression $AB + CD - * E ? F + /$
- (a) (5 pts) What is its prefix form?
- (b) (10 pts) The prefix and postfix expressions are parenthesis-free and thus easy to evaluate using STACK. Now we are modifying the postfix evaluation algorithm (explained in our course) to get its corresponding prefix version. What and how should we modify?
9. (20 pts) In a hash structure, the key K is mapped into a hash table of M slots (indexed from 0 to $M-1$), where K (key value) and M (size of hash table) are integers. Out of the following hash functions $h(K)$,

(1)	$h(K) = K/M,$	where M is a prime number
(2)	$h(K) = K \bmod M,$	where M is an odd number
(3)	$h(K) = K^2 \bmod M,$	where M is a prime number
(4)	$h(K) = (K + \text{Random}(M)) \bmod M,$ where $\text{Random}(M)$ returns a random integer between 1 and $M-1$	

- (a) Which one(s) may be unacceptable as a hash function? Describe the reason(s) in short?
- (b) Out of the acceptable ones, which one is the best?