一、单项选择题（本大题共 15 小题，每小题 2 分，共 30 分） 提示：在每小题列出的备选项中只有一个是符合题目要求的，请将其代码写到答题纸上。错选、多选或未选均无分。

1. An algorithm must be or do all of the following EXCEPT:
   a) correct
   b) composed of concrete steps
   c) ambiguous
   d) composed of a finite number of steps
   e) terminate

2. log nm is equal to
   a) n + m
   b) log n + log m
   c) m log n
   d) log n - log m

3. The best case for an algorithm refers to:
   a) The smallest possible input size.
   b) The specific input instance of a given size that gives the lowest cost.
   c) The largest possible input size that meets the required growth rate.
   d) The specific input instance of a given size that gives the greatest cost.

4. Finding the element in an array-based list with a given key value requires worst case time:
   a) $O(1)$.
   b) $O(\log n)$.
   c) $O(n)$.
   d) $O(n^2)$.

5. The relationship between a full and a complete binary tree is:
   a) Every complete binary tree is full.
   b) Every full binary tree is complete.
   c) None of the above.

6. The easiest way to represent a general tree is to:
   a) convert to a list.
   b) convert to a binary tree.
   c) convert to a graph.

7. The number of permutations of size n is:
   a) $O(\log n)$.
   b) $O(n)$.
   c) $O(n \log n)$.
   d) $O(n^2)$
   e) $O(n!)$
   f) None of the above.

8. In external sorting, a run is:
   a) A sorted sub-section for a list of records.
   b) One pass through a file being sorted.
   c) The external sorting process itself.

9. A good hash function will:
   a) Use the high-order bits of the key value.
   b) Use the middle bits of the key value.

c) Use the low-order bits of the key value.

d) Make use of all bits in the key value.

10. The primary key is:

a) A unique identifier for a record.

b) The main search key used by users of the database.

c) The first key in the index.

11. The single-source shortest path problem can be used to:

a) Sort all of the graph vertices by value.

b) Sort all of the graph vertices so that each vertex is listed prior to any others that depend on it.

c) Sort all of the graph vertices by distance from the source vertex.

12. All operations on a stack can be implemented in constant time except:

a) Push

b) Pop

c) The implementor's choice of push or pop (they cannot both be implemented in constant time).

d) None of the above.

13. A collision resolution technique that places all records directly into the hash table is called:

a) Open hashing.

b) Separate chaining.

c) Closed hashing.

d) Probe function.

14. If an algorithm is Theta(f(n)) in the average case, then it is:

a) Omega(f(n)) in the best case.

b) Omega(f(n)) in the worst case.

c) O(f(n)) in the worst case.

15. When comparing the doubly and singly linked list implementations, we find that the doubly linked list implementation

a) Saves time on some operations at the expense of additional space.

b) Saves neither time nor space, but is easier to implement.

c) Saves neither time nor space, and is also harder to implement.

二、名词解释题（本大题共 2 小题，每小题 4 分，共 8 分）提示：对题目名词进行解释，英文缩写的需要给出全称并解释。

1. Complete Binary Tree

2. MST

三、应用题（本大题共 4 小题，每小题 8 分，共 32 分）。

1. Given an array containing the elements {71, 80, 66, 59, 82, 25, 94, 69}. Show how the order of the elements changes during the first pass of quicksort (choosing the last element of the array to be the pivot). Show the array after each swap.

2. A 10 element complete binary tree is represented by the array [12, 70, 33, 65, 24, 56, 48, 92, 86, 33]. Draw the complete binary tree. Is this complete binary tree a min heap? If not, construct the min heap.

3. Delete 33 from the B+ tree of order four.
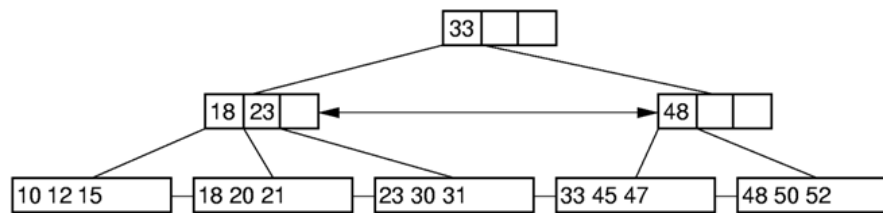
4. Build a hash table of 12, 23, 45, 57, 20, 03, 78, 32, 15, 33, using hash function H(key) = key MOD 13. Using double hashing solve collisions, and the second hash function is H2(key) = (7*key) MOD 11 + 1. The size of hush table n=13.

## 四、编程、设计及分析题（本大题共 2 小题，共 20 分）。提示：题目给出了一个程序设计要求，请按照要求写出源程序代码，如果源程序代码中出现语法错误或逻辑错误，则酌情扣分。

1. Write a function to reverse the order of the elements on the singly-linked list. Your algorithm should run in $\Theta(n)$ time for a list of n elements.

2. The data fields of a binary tree are single characters. The class of binary tree node is given below.

```
class BinNodePtr{
public:
    char val;           //value
    BinNodePtr* lc;    //left child
    BinNodePtr* rc;    //right child
}
BinNodePtr root;    // root node
```

You are to write a method **printTree(BinNodePtr root)** which prints the nodes data value in the shape like the following example.

Example:
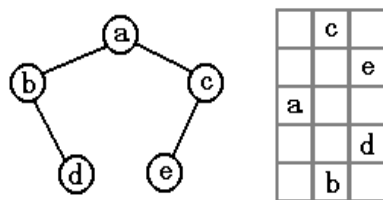
Binary tree   Result of printTree