1. Given the following algorithm for recursive merge sort.

```c
int rmerge (element list[], int lower, int upper)
{
    int middle;
    if (lower >= upper)
        return lower;
    else {
        middle = (lower + upper) / 2;
        return listmerge(list, rmerge(list, lower, middle),
            rmerge(list, middle+1, upper));
    }
}
```

(a) (3%) Produce a simulation of recursive merge sort for the case when the input file
to be sorted is `< 25 10 35 50 45 20 5 30 40 15 >`
(b) (2%) Is the merge sort stable? Why?

2. Given a binary search tree. Each node in the tree has three fields, left_child, value,
and right_child, and defined in C as:

```c
typedef struct node * tree_pointer;
typedef struct node {
    int value;
    tree_pointer left_child, right_child;
};
```

(a) (6%) Write a recursive algorithm to insert a node with data value `num` into a
binary search tree.
(b) (3%) Analyze the time complexity of your algorithm.

3. Given a graph G, in which G is represented by adjacency matrix, adj[i][j]. If there
is an edge (v_i, v_j) in G, then adj[i][j] = 1; otherwise adj[i][j] = 0.
(a) (7 %) Write an algorithm to determine the connected components of a graph G.
(b) (3 %) Analyze the time complexity of your algorithm.
4.

(i) The data structure `purchased_items` links the product items each customer had purchased. Let N be the total number of customers and M be the total number of product items, respectively. An array `customers[]` is used to record the purchased product items for N customers. An array `itemid_name[]` can be used to find the item name indexed by the identity (item_no) of the product item.

(ii) An association between two product items can be defined as the following. Two product items P and Q are associated, denoted as \( P \approx Q \), if the number of customers, who had purchased both P and Q, is greater than a threshold T. Notably, a customer C had purchased both P and Q, if P and Q are included in the items purchased by C. Additionally, if P and Q are associated, then Q and P are also associated. However, \( P \approx Q \) and \( Q \approx R \) do NOT imply \( P \approx R \).

(a) (8%) Write an algorithm to find all the associations among product items. You should use the data structure `assoc[][]` to store the associations. Specify additional data structures used in your algorithm.

(b) (3%) Analyze the time complexity of your algorithm.

(c) (5%) Based on the associations established in (a), you may recommend your customers to buy associated product items. Assume that `itemid_name[]` has been created. Given a product item with name `Iname`, write an algorithm to find all the product items associated with `Iname`.

```c
struct item {
    int   item_no; /* unique number to identify a product item */
    char name[30]; /* 0 \leq item_no < M */
};
struct item_list {
    struct item product;
    struct item_list *next;
};
typedef struct item_list *purchased_items;
purchased_items customers[N];
struct assoc_info {
    int   customer_count;
    int   associated;       /* 0: No; 1: Yes */
};
struct assoc_info assoc[M][M];
struct item_name {
    char   name[30];
}
```
5. (a) What are C2B and C2C e-commerce? Please also show a representative website for C2B and C2C business model respectively. (8%) In addition, what is the “last mile” service in Internet economy? (4%)

6. Can you explain the difference between “brick and mortar” and “click and mortar” company? (4%)

7. What is the peer-to-peer computing? How is it different from the client-server model? (8%)

8. What are the advantages and disadvantages of Proxy servers? (6%)

9.
   a) Why can’t a user program directly access the internet protocol (IP) without the transmission control protocol (TCP) or the user datagram protocol (UDP)? (8)
   b) Why is UDP needed? (7)

10.
   a) Why is the concept of the quality of service (QoS) important to today’s Internet? (8)
   b) What is the mechanism recommended by the Internet to ensure the desired QoS? Detail the mechanism. (7)