1. (10%) An important theoretical function, known as Ackermann's function, is defined as

\[
A(M,N) = \begin{cases} 
N+1 & \text{if } M=0 \\
A(M-1,1) & \text{if } N=0 \\
A(M-1,A(M,N-1)) & \text{otherwise}
\end{cases}
\]

Please write up a recursive function sub-algorithm, in pseudo code, for this function.

2. (10%) What do we mean by a physical machine? A virtual machine?

3. (10%) What is time sharing? What special features of time sharing distinguish it from other forms of multiprogramming?

4. (10%) It is instructive to consider the general case of moving a node from the middle of one linked list to the middle of another. Suppose x and y point to nodes of linked lists and we want the node after x to be removed and inserted after y. Please show the order of assignments in pseudo code.

5. (10%) Add two 8-bit two's complement numbers, what kind of conditions will cause an overflow state.

6. (8%) Write a pseudo code for the bubble sort.
   (b) (7%) What is the worst case time complexity of your algorithm?

7. (10%) Specify the functions of each layer in the ISO/OSI network model.
8. (15%) Consider

What are the final values of X and Y if parameters are handled:
   (a) by value
   (b) by address
   (c) by name

9. (10%) Specify the key characteristics of the following data structures:
   (a) array   (b) linked-list
   (c) stack   (d) queue
   (d) record