1. (10%) Draw the max heap (i.e. the maximum at the top) that results when the following operations are performed on an initially empty heap: insert(1), insert(5), insert(2), insert(6), insert(8), remove, insert(7), insert(3).

2. (10%) Draw the top-down 2-3-4 tree built when the keys HARDQUESTIION are inserted (in that order) into an initially empty tree.

3. (10%) Suppose that the dimensions of the matrices A, B, C, and D are 50x10, 10x40, 40x30, and 30x5, respectively. We want to know how best to compute \(A \times B \times C \times D\). Show the table and the order of multiplication.

4. (10%) (a) What are NP-complete problems?
   (b) How can you prove that a problem is NP-complete?

5. (10%)
   ```
   int recursive(int n)
   {
     if (n <= 1) return 1;
     return recursive(n-1) + recursive(n-1);
   }
   ```
   Write down the recurrence equation for the time complexity of function recursive and solve it.
6. **Explaining Terms** [20pts]
   
   (a) Die (in VLSI)
   
   (b) Caller Save
   
   (c) Computer Family
   
   (d) Data Hazard

7. A computer instruction set has 8 instructions. 5 of them are given below:
   add, sub, or, load, jump
   The other three are left for you to determine. What will you choose? Justify your answer. [15pts]

8. Will you use software or hardware approach to handle the following misses? Justify your answer. [15pts]
   
   (a) TLB miss.
   
   (b) Cache miss
   
   (c) Page fault.