Problem 1 (10 points)
Explain the following terms:

Database

Database management systems

Data Model

Data Schema

Data Independence
Problem 2 (10 points) Define the term binary relation mathematically. Give examples of binary relations that are

a. Reflexive and symmetric but not transitive
b. Reflexive and transitive but not symmetric,

c. Symmetric and transitive but not reflexive
Problem 3 (20 points)
Give a binary search tree below, show the results of the following operations (assuming results from the previous operation is visible for the next operation)

1. Search for key 9
2. Search for key 18
3. Insert 12
4. Insert 7
5. Delete 10
6. Delete node 15
**Problem 4 (20 points)** Given the following graph, compute the shortest path from (i) node 5 to node 2 and (ii) node 4 to node 1.
Problem 5 (20 points)
There are two programs that may run concurrently in computer. The C style code of the two programs is given below:

Program 1
{
    Y = X;
    Y = Y + 1;
    X = Y;
}

Program 2
{
    Z = X;
    Z = Z + 4;
    X = Z;
}

We assume that X is a shared variable between the two programs and X is initialized to 1 BEFORE both programs starting to run. Two programs may share a variable by shared buffer or by message passing, the lower level OS mechanism is not important for this problem.

Please list THREE possible values for X when both programs stop. Justify your results.
Problem 6 (20 points)
We have measured a variable X ten times and we obtained the following 10 measurements: 10.0, 9.9, 10.1, 10.2, 10.0, 9.5, 10.2, 9.8, 10.3, 9.6.
Compute (1) the mean of X, (2) the standard deviation of X. Show how the values are computed in your computation. (3) does X satisfy the normal distribution?
Extra credit Problem 7 (5 points)
Write down your comments for the class so far (too fast, too slow, covered too much materials, covered too little materials, etc)