Answer all questions on the exam. Total: 100 points. Good Luck.

1. (10 pts) Using the big-O notation, estimate the running time of proc(N) in terms of N. Explain your answer.

```c
void proc(int x)
{
    int i, j, k;
    for (i = 0; i < 10; i++)
        for (j = 0; j < x; j++)
            for (k = x; k > 0; k = k/2)
                /* constant-time operation */
}
```

2. (15 pts)
   (a) What are the best-case and worst-case time complexities (in big-O) of locating an item in a hash table? Explain.
   (b) What is a collision in hashing?
   (c) Describe two collision resolution strategies and illustrate with examples.

3. (40 pts) Using C, C++, or pseudocode with sufficient details:
   (a) Write a procedure that performs selection sort in ascending order on an array of integer elements.
   (b) Use class/struct to represent a singly linked list of integer items and write a recursive function that prints a singly linked list in reverse order.

4. (25 pts) Given the following graph:

(a) Perform the Dijkstra's algorithm to find the shortest path from node A to node D. Show your steps.
(b) Assume the edges are undirected, perform a minimal spanning tree algorithm. Show your steps.

5. (10 pts) Given these numbers 2 8 3 1 9 4 in an array, perform Quicksort (in ascending order) and draw the array after each partitioning step.