Boğaziçi University, Dept. of Computer Engineering

CMPE 250, DATA STRUCTURES AND ALGORITHMS

Spring 2011, Midterm 2

Name: _____

Student ID: _____

Signature: _____

- Please print your name and student ID number and write your signature to indicate that you accept the University honour code.
- During this examination, you may not use any notes or books.
- Read each question carefully and **WRITE CLEARLY**. Unreadable answers will not get any credit.
- There are **5** questions. Point values are given in parentheses.
- You have **120 minutes** to do all the problems.

Q	1	2	3	4	5	Total
Score						
Max	20	20	20	20	20	100

1. What is .. (Give short answers. Long answers do not get any credit.)

   1.1 the notation $O(g(n)) = f(n)$? (2pt)

   1.2 the notation $o(g(n)) = f(n)$? (2pt)

   1.3 an example application where a heap is useful ?

   1.4 a graph ?

   1.5 a sparse graph ?

   1.6 a hypergraph?

   1.7 a shortest path tree?

   1.8 a Greedy algorithm?

   1.9 Dijkstra's algorithm?

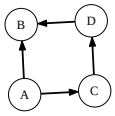
   1.10 a Breadth first search ?

   1.11 what is a copy constructor?

   1.12 what is indirect sort?

   1.13 a pivot (in the context of quicksort) ?

   1.14 For the following graph can you find two topological sequences? If yes show them, If no state why(4 pts)



(30 points)

2. Fill in the following table. (Leave empty if you are unsure as a wrong answer cancels one right answer)

	Insertion Sort	Heapsort	Mergesort	Quicksort
Worst case time complexity				
Average case time complexity				
In place? (yes/no)				
Stable? (yes/no)				
Sequence num (2pts each)				

Below, the column on the left is the original input of strings to be sorted; the column on the right are the string in sorted order; the other columns are the contents at some intermediate step during one of the 4 sorting algorithms listed above. Match up each column by writing its number to the corresponding row labeled as 'sequence'. Use each number exactly once.

[Hint: In place: Do we need extra storage other than a few temporary variables of size O(1)? Stable: if two keys are the same, is their original order in the unsorted array guaranteed to be kept after sorting?]

```
COS ARC CHE REL ARC ARC
PHY CHE COS PHY CHE ART
ELE COS CHM PHY COS CEE
COS COS COS ELE COS CHE
MAT ECO COS PHI ECO CHM
MOL EEB ART ORF ELE COS
LIN ELE CEE ORF GEO COS
ARC ELE ARC COS LIN COS
ECO ENG COS ELE MAE COS
CHE GEO COS EEB MAT COS
MAE LIN MAE MUS MOL COS
GEO MAE GEO GEO PHY ECO
ORF MAT ORF ORF ORF EEB
EEB MOL EEB MAT EEB EEB
ENG ORF ENG LIN ENG ELE
ELE PHY ELE COS ELE ELE
COS ART ECO COS COS ELE
ELE CEE ELE ECO ELE ENG
CEE COS LIN CEE CEE GEO
EEB EEB EEB CHE EEB LIN
ART ELE MOL ART ART MAE
MUS MUS MUS MAT MUS MAT
PHI ORF PHI MAE PHI MAT
ORF PHI ORF ELE ORF MOL
COS COS MAT COS COS MUS
PHY PHY PHY MOL PHY ORF
COS COS COS COS COS ORF
MAT MAT MAT EEB MAT ORF
CHM CHM ELE CHM CHM PHI
ORF ORF ORF ENG ORF PHY
COS COS PHY COS COS PHY
REL REL REL ARC REL REL
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 U   1   2   3   4   S
```
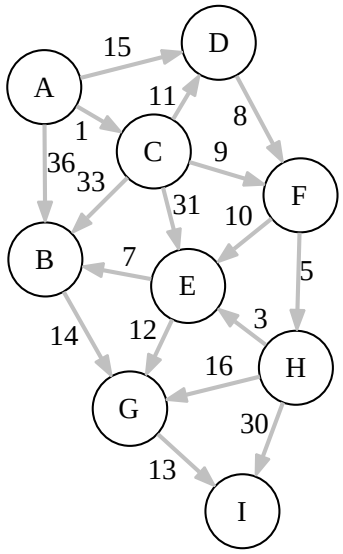

3. Run Dijkstra's algorithm on the weighted digraph below, starting at vertex A.



3.1 List the vertices in the order in which the vertices are dequeued (for the first time) from the priority queue and give the length of the shortest path from A.

```
vertex:  A C ___ ___ ___ ___ ___ ___ ___
distance: 0 1 ___ ___ ___ ___ ___ ___ ___
```

3.2 Draw the edges in the shortest path tree with thick lines in the figure above.

(20 points)

4. A bipartite graph is a graph such that the vertex set can be partitioned into two subsets such that no edge has both its vertices in the same subset. Give a linear algorithm to determine whether a graph is bipartite. *(20 points)*

5. Suppose a directed graph G is given by its adjacency list.

   5.1 Write an almost complete algorithm in C++ (like the codes shown during the lectures) to compute the adjacency list of a new graph G' that contains all arcs of G but pointing to the opposite direction. For example if $G : a \leftarrow b \leftarrow c$ then $G' : a \rightarrow b \rightarrow c$.

(20 points)