Computer Science 303 **Exam 2** **Paul Cao**

4/7/2014, Monday in class This is a close-book close-notes exam.

Your name Junjun Huang

66/100

TIME LIMIT: 50 MIN

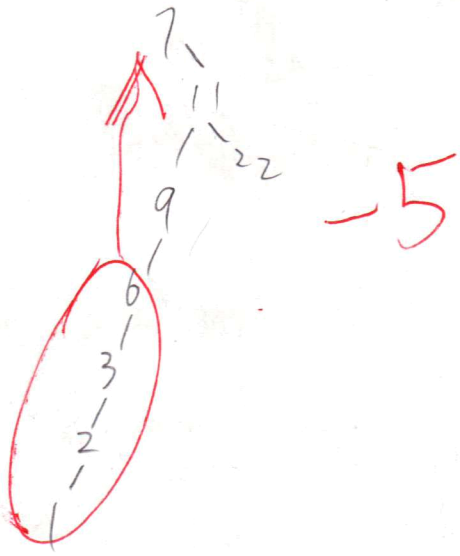
Please read the following instructions carefully.

You have 50 minutes to work on this exam, which has 5 problems. The total points of this exam are 100. **You may use a 3x5 card with notes written on both sides during this exam.** Other reference sources, such as textbook, in class notes, homework solutions, online resources, and discussions with other students are not allowed. You may use blank sheets of paper for scratch-work, but please put your answers and the work you want to be graded on the exam. You may get partial credits if you show your work. **You must sign the honor code in the provided space under the last problem. The honor code is "I affirm that I have adhered to the Ashland University honor code on this exam".**

You need to provide detailed steps for every problem unless you are instructed not to do so in the problem.

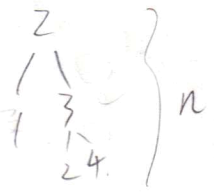
Good luck!

1. Binary tree (30 points)
(a). (15 points) Build a binary search tree with the following data
7, 11, 22, 9, 6, 3, 2, 1



(b). (10 points) Given a binary tree, propose an algorithm that verifies if this binary tree is a binary search tree. Analyze the efficiency of your algorithm.

$\Theta(n)$



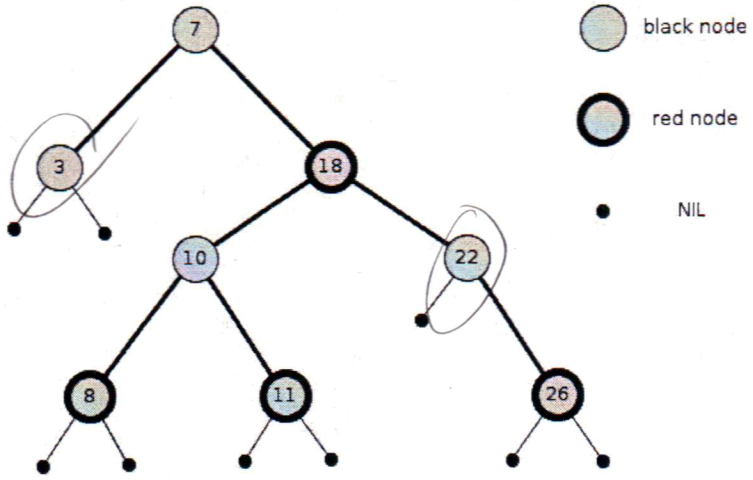
if x.right ≠ NIL
return BST-Min(x.right)
y = x.p

while y ≠ NIL and x == y.right

x = y ?
y = y.p -5
return y

algorithm isn't clear.

(c). (5 points) Given the following tree, please verify if the tree is a red-black tree.



① It's a BST

∵ 3 and 22 -3

∴ not a RBT ?

2. Dynamic Programming (15 points)
Find the optimal alignment of the following two sequences using dynamic programming. You only need to report one optimal alignment if there are multiple optimal alignments. You must show your steps. A simple alignment result will receive no credits.
x: AG
y: ACG

The scoring is:
match: +1
mismatch: -1
gap: -2

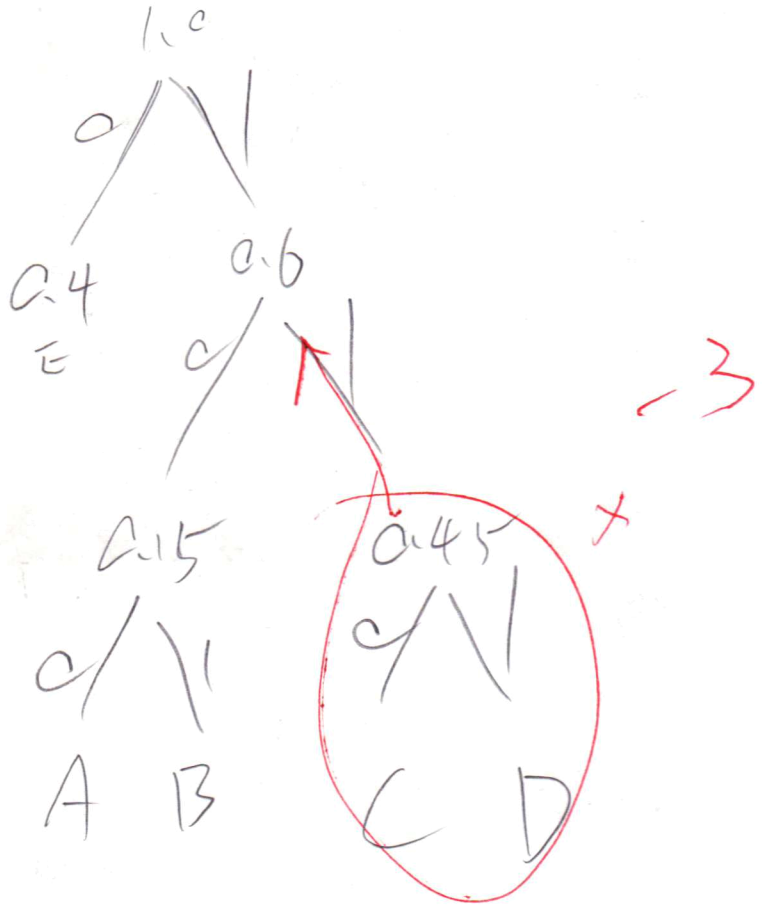
$$\max \begin{cases} V(i-1, j-1) + S(x_i, y_j) \\ V(i, j-1) - g \\ V(i-1, j) - g \end{cases}$$

A - G
A C G

		A	C	G
	0	-2	-4	-6
A	-2	1	-1	-3
G	-4	-1	0	0

3. Greedy algorithms (10 points)
Find the Huffman code of the following characters given their frequency. Make sure you provide steps in finding the Huffman tree.

A: .05
B: .10
C: .22
D: .23
E: .40



A: 100

B: 101

C: 110

D: 111

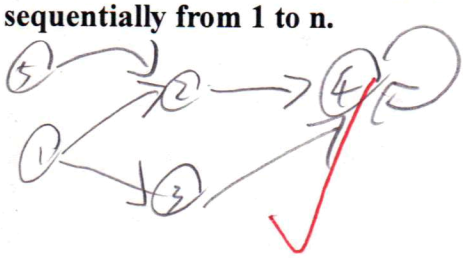
E: 0

4. Graph and Minimum Spanning Tree (30 points)

(a). (16 points) Given the following adjacency matrices or lists of digraphs, draw the graphs. You can assume the vertices are numbered sequentially from 1 to n.

-

	1	2	3	4	5
1	0	1	1	0	0
2	0	0	0	1	0
3	0	0	0	1	0
4	0	0	0	1	0
5	0	1	0	0	0



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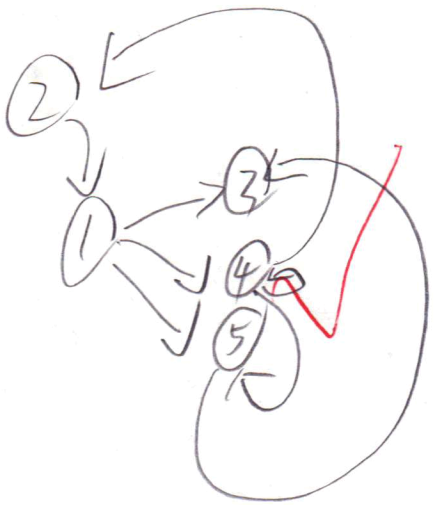
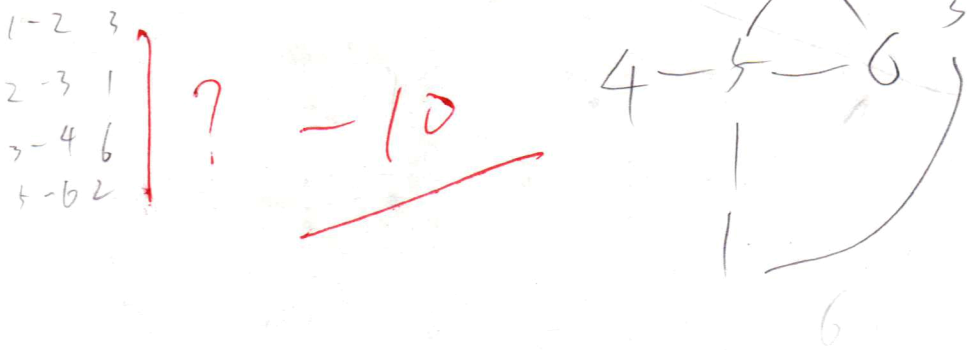
i	vertices
1	3,4,5
2	1
3	NULL
4	2,4,5
5	3

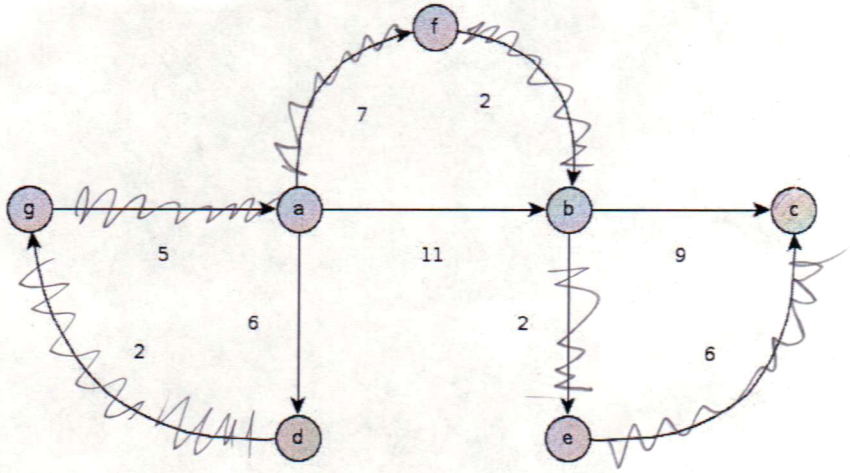


(b). (14 points) Use Prim's algorithm to find the MST of the following undirected graph given as a weight matrix. Show all your steps to receive full credits.

	1	2	3	4	5	6
1	∞	3	∞	∞	6	5
2	3	∞	1	∞	∞	4
3	∞	1	∞	6	∞	∞
4	∞	∞	6	∞	8	5
5	6	∞	∞	8	∞	2
6	5	4	∞	5	2	∞



5. Shortest path (15 points)
Find the shortest path from a to all other nodes in the following graph. Feel free to pick any algorithm. Clearly state which algorithm you picked and write out all steps.



Write and sign the honor code here.