King Fahd University of Petroleum & Minerals

College of Computer Science and Engineering
Information and Computer Science Department
Second Semester 132 (2013/2014)

ICS 202 – Data Structures
Final Exam
Sunday, May 18th, 2014
Time: 120 minutes

Name: _____

ID# | | | | | | | | | |

Section 01 Dr. Sami
Section 02 Dr. Ramadan

Question #	Max Marks	Marks Obtained
1	24	
2	26	
3	15	
4	15	
5	20	
Total	100	

Instructions

1. Write your name and ID in the respective boxes above and circle your section.
2. This exam consists of 10 pages, including this page, plus one reference sheet, containing 6 questions.
3. You have to answer all 5 questions.
4. The exam is closed book and closed notes. No calculators or any helping aids are allowed.
5. Make sure you turn off your mobile phone and keep it in your pocket if you have one.
6. The questions are not equally weighed.
7. The maximum number of points for this exam is 100.
8. You have exactly 120 minutes to finish the exam.
9. Make sure your answers are readable.
10. If there is no space on the front of the page, feel free to use the back of the page. Make sure you indicate this in order not to miss grading it.

Q.1 [24 points] Multiple Choice Questions: Mark the best answer for each question below. Note: only one choice should be chosen.

1. Consider the following code segment

```
sum = 0;
for (j=1; j<=n; j++)
    for (k=1; k<=j; k++)
       sum++; // Statement 1
```

The complexity of the above code segment is

   a. O (n^2)
   b. O (n log n)
   c. O (n)
   d. O (log n)
   e. none of the above.

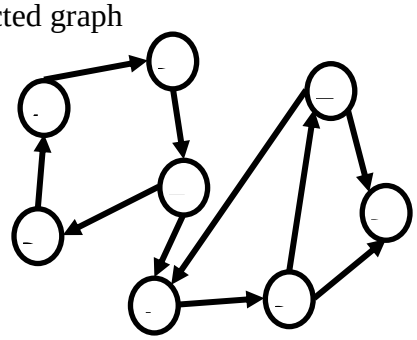
2. In the worst case searching an imbalanced Binary Search Tree is

   a. O (log n)
   b. O (n log n)
   c. O (n)
   d. O ($2^n - 1$)
   e. none of the above.

3. The run-length encoding of the string EEESSSEEE:
   a. is ESE3.
   b. is E3S3E3.
   c. is 3ESE.
   d. can be both answers a and b.
   e. can be all answers a, b and c.

4. The postfix expression: `9 9 7 - - 3 4 + 8 6 - * +` evaluates to
   a. 0.
   b. – 25.
   c. – 7.
   d. 17.
   e. 21.

5. Consider the following directed graph

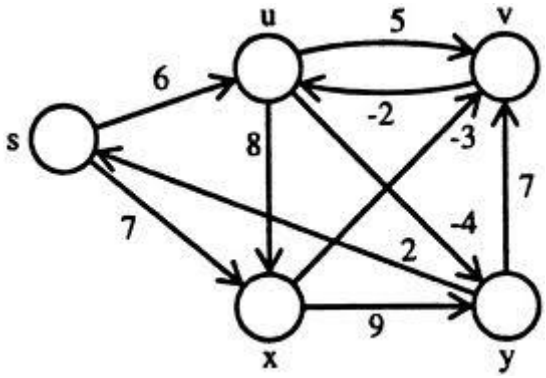


The number of strongly connected components is equal to

a. 5
b. 4
c. 3
d. 2
e. 1

Q2. [26 points] (Graphs):

A. Consider the following weighted directed graph $G_A(V_A, E_A, W_A)$, where W_A is the set of edge weights:



a) [4 points] Is it possible to solve the shortest path problem for the above graph? Justify your answer

Yes, since there are no negative cost cycles

b) [2 points] Is Dijkstra algorithm applicable on the above graph?

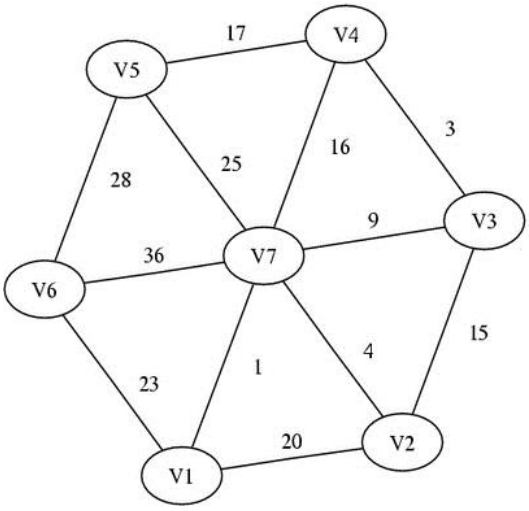
No, Djakarta algorithm only works for positive weights

B. [10 points] Consider the weighted directed graph GA in the first part of the question, Let's construct a new weighted directed graph GB (VB, EB, WB), where VB = VA , EB = EA , and WB is the absolute value of the corresponding value in WA. Apply Dijkstra algorithm to find the shortest path to any vertex starting from vertex s. Show the obtained tree of the shortest paths.

Pass	initially						weight	Predecessor
Active Vertex								
s								
u								
v								
x								
y								

Pass		1	2	3	4	5			
Active Vertex	initially	s	u	x	v	y		weight	Predecessor
s	0							0	
u	-1	6						6	s
v	-1	-1	11	10				10	x
x	-1	7	7					7	s
y	-1	-1	10	10	10			10	u

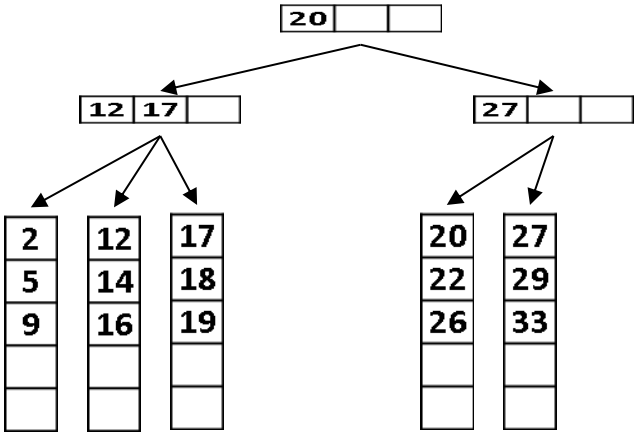
C. [10 points] Consider the following weighted undirected graph. Apply prim's algorithm to find a minimum spanning tree of the graph starting from V7. Show the minimum spanning tree.



Pass										
Active Vertex	initially	V7	V1	v2	v3	v4	v5	v6	weight	V
V1	-1	1							1	V7
V2	-1	4	4						4	v7
V3	-1	9	9	9					9	v7
V4	-1	16	16	16	3				3	v3
V5	-1	25	25	25	25	17			17	v4
V6	-1	36	23	23	23	23	23		23	v1
V7	0								0	

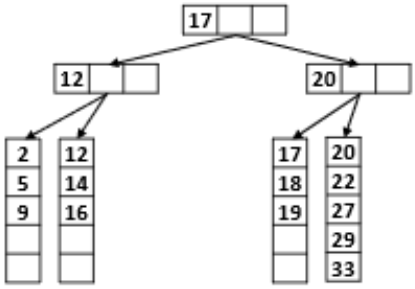
V2									
V3									
V4									
V5									
V6									
V7									

Q3. [15 points] (B+ Trees)
Consider the following B+ Tree where M=4 and L=5

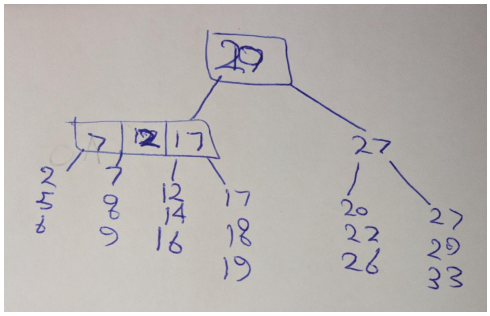


Show the B+ Tree after each one of the following operations (note that all operations are independent, that is, in b perform the operation on the original B+ Tree, not the one obtained after performing the operation in a).

a) Delete(29)



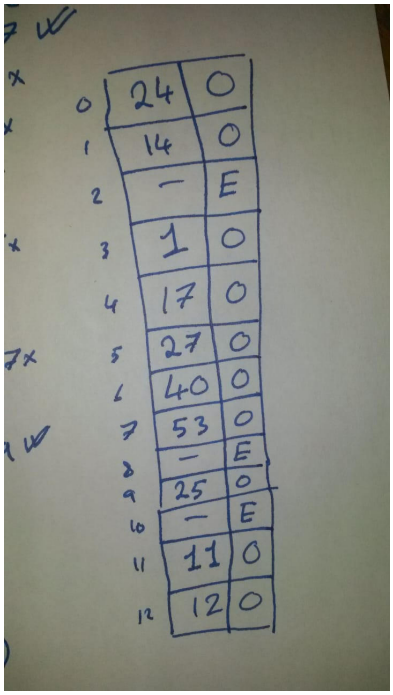
b) Insert(6), Insert(7), Insert(8) (show only the B+ Tree after all 3 operations)



Q4. [15 points]: (Hashing)

Consider an open-addressing hash table of size 13 where the hash function is **h(Key)=Key % 13** and a second hash function is used for probing: **h_p(Key) = 1 + Key % 12.** Show the computation steps as well the final hash table when inserting the following values:

14, 11, 17, 12, 27, 1, 40, 24, 53, 25

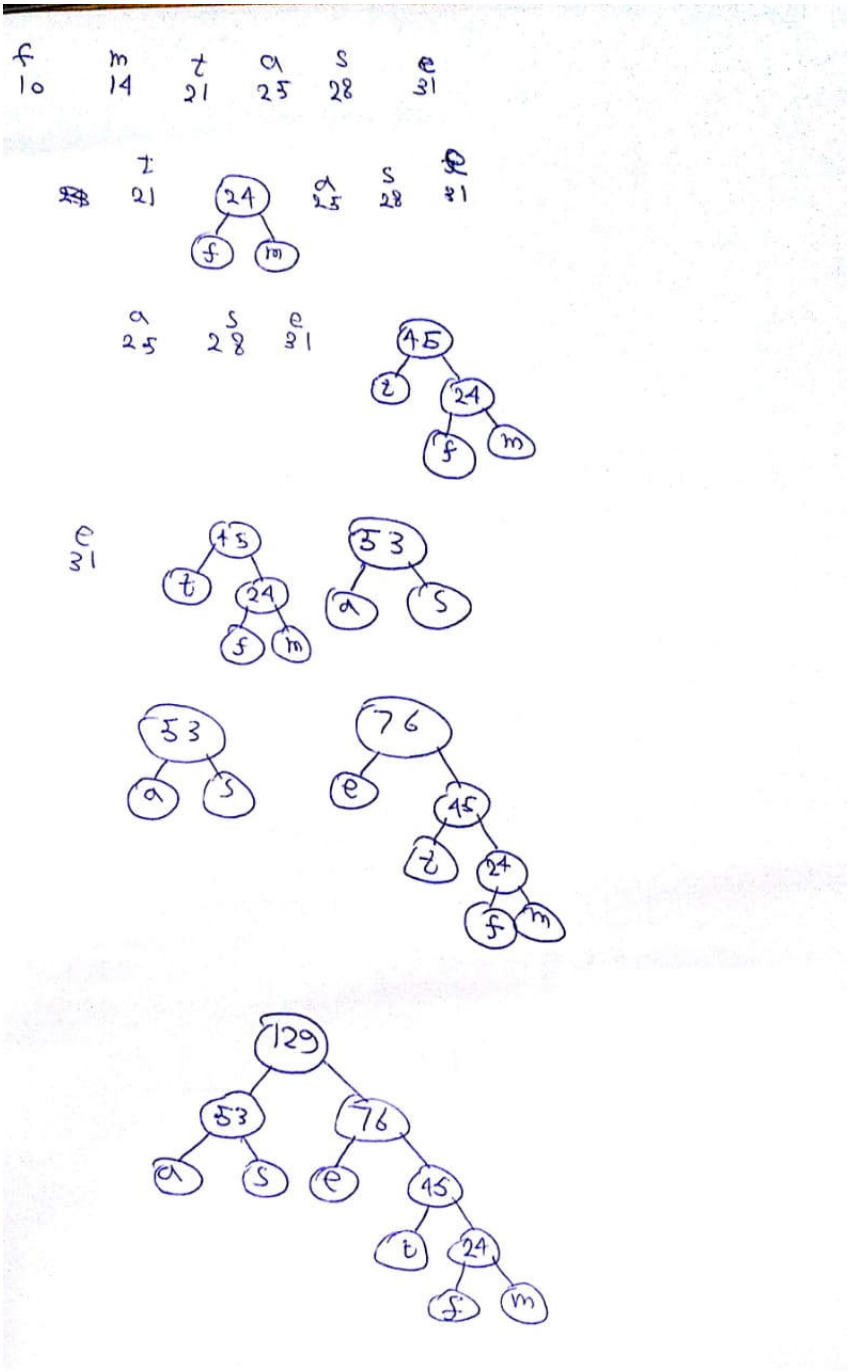


Q5. [20 points]: (Compression)

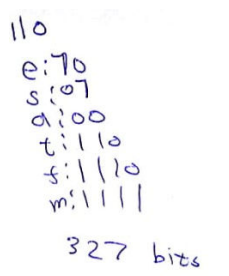
Part A) Huffman Coding
Assuming that a text file contains only the following characters with their corresponding frequencies:

Character	m	s	e	f	a	t
Frequency	14	28	31	10	25	21

a) [7 points] Build the Huffman code tree for the text file message. You should show all the steps of the tree construction



b) [3 points] Use the Huffman tree to find the codeword for each character.



c) [5 points] What is the total number of bits of the compressed message? What is the compression ratio? Show your computations

original message: 129*8=1032

compressed message: 3+17+6*8+327=395

395/1032=38% of original bits

Part B) Lempel-Ziv Compression
Compress the following message using LZ-78. (You must show the compression table):

BAABCAACCBAAABCA