COMSATS University Islamabad, Lahore Campus
Terminal Examination – FALL 2020

Course Title:	Design and Analysis of Algorithms		Course Code:	CSC301	Credit Hours: 3(3,0)
Course Instructor/s:	Dr. Hasan Jamal		Programme: Name:	BCS	
Time Allowed:	**3 Hours**	**Maximum Marks:**	**80**	Date:	13/01/2021
Student's Name:			Reg. No.		

Question 1: **[Marks: 5]**

Prove or disprove that $\frac{1}{2}n^2 - \frac{1}{6}n + 6 \in \Omega(n)$

Question 2: **[Marks: 10]**

Solve the following recurrence using the "Recursion Tree Method"

$$T(n) = 4T\left(\frac{n}{3}\right) + n$$

Question 3: **[Marks: 5]**

Solve the following recurrence using the "Master Method"

$$T(n) = 9T\left(\frac{n}{3}\right) + n \lg n$$

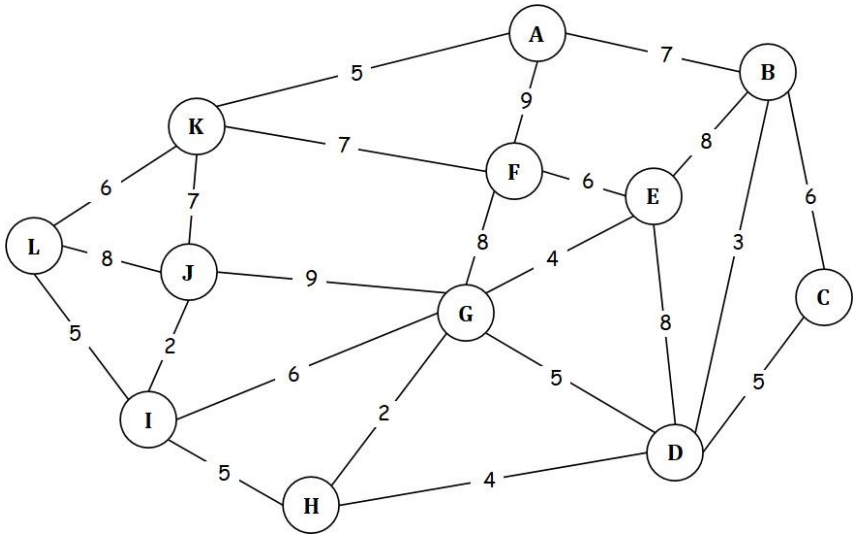
Question 4: **[Marks: 10]**

Given a hash table of size 13 and a hash function H(k) = K mod 13, draw the contents of the hash table if open addressing with quadratic probing is used to resolve collisions. What values will be in the hash table after the following sequence of insertions? Show your working for partial credit.

15, 28, 21, 18, 13, 6, 37, 3, 31, 44

Question 5: **[Marks: 05+02+01+02= 10]**

Given the following undirected, weighted graph.



(a) Step through Dijkstra's algorithm to calculate the single-source shortest paths from vertex "A" to every other vertex by filling in the table as done in class. Cross out old values and write in new ones, from left to right, as the algorithm proceeds.
(b) Write down the order in which Dijkstra's algorithm would mark each node as known.
(c) Write down the shortest (weighted) path from A to L and its length (weighted cost).
(d) Draw the minimum Spanning Tree of the graph.

Question 6: **[Marks: 03+02 = 05]**

A Quad-core server has a total computing capacity of 8 GHz (4 x 2 GHz). Virtual machines of various sizes running multiples tasks can be placed on each core of the server, provided there is sufficient computing capacity available on the sever core. Given below are the virtual machine requests (in GHz) that need to be placed on the server for execution.

1.6, 0.7, 0.5, 1.2, 0.8, 0.6, 1.3, 1.0, 0.3

What is the optimal placement of the virtual machines on the server if:

(a) the virtual machine requests arrive in the given order
(b) all virtual machine requests are available in advance.

Note: It is not necessary that all virtual machine request would be satisfied.

Question 7: **[Marks: 04+06 = 10]**

Find out the "Fixed Length" and "Variable Length" codes for the characters in the given table below.

Characters	H	T	I	S	R	N	E	A
Frequency	6	28	17	39	12	11	60	28

Question 8: **[Marks: 06+01+01+02 = 10]**

Your friend Ali is coming home from Dubai and wants to pack his bag that gives him maximum benefit. He has one bag with capacity W=13 and he want to utilize that to carry maximum number of items with overall best benefit in terms of value. He is having trouble filling the bag to maximize benefit. He has called you for some provide him a quick solution to his problem. Following table shows the list of 6 items (i) along with corresponding weights (w_i) and values (b_i). Help him out in getting the maximum benefit out of it as you yourself want maximum value gifts from him.

Item #	w_i **(weight of ith item)**	b_i **(value of ith item)**
I_1	5	9
I_2	4	5
I_3	2	6
I_4	3	4
I_5	1	3
I_6	7	6

a) What is the maximum value/benefit (B) that can be achieved?
b) Item number/s that can be added in the bag to achieve the above max value/benefit (B)?
c) If an item I_7 is introduced with $w_7 = 2$ and $b_7 = 7$. What effect would this item have on the value of B? Show your working.

Question 9: **[Marks: 5]**

Suppose you are given many .CSV files containing unsorted data. Your job is to sort all the data from those files into one file and remove all the duplicate values. What is the optimal way to solve this problem?

Question 10: **[Marks: 10]**

We have 3 assembly-lines in a car manufacturing factory each of which has 5 service stations. All the costs are shown in the figure below. Find out the fastest way through the factory using the "dynamic programming" approach.