

Birla Institute of Technology & Science, Pilani
Work-Integrated Learning Programmes Division
Second Semester 2020-2019
M.Tech (DSE)
Mid-Semester Test (EC-2 Regular)

Course No. : DSECFZG519
 Course Title : DATA STRUCTURE ALGORITHMS AND DESIGN
 Nature of Exam : Open Book
 Weightage : 30%
 Duration : **90 Min**
 Date of Exam : 28-06-2020

No. of Pages = 3
No. of Questions = 7

Note:

1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. **Assumptions made if any, should be stated clearly at the beginning of your answer.**

1. Suppose there are n (mostly) identical robots in a room, each of which is capable of testing each other for speed. The testing equipment can test 2 robots at a time. During the test each Robot will tell whether the other one is fast or slow. A fast robot always reports correctly whether the other one is fast/slow. But the answer of a slow robot cannot be trusted. [2+2=4M]

The possible outcomes are

R1 Reports	R2 reports	Comment
R2 is fast	R1 is fast	Both are fast, or both are slow
R2 is fast	R1 is slow	at least one is slow
R2 is slow	R1 is fast	at least one is slow
R2 is slow	R1 is slow	at least one is slow

Consider the problem of finding one fast robot from among n robots

Assumption: More than half of the robots are fast.

- a. Give and solve the recurrence that describes the number of tests $T(n)$ needed to find a single fast robot from n robots. Hint: Number of tests needed to reduce the problem size to half= $n/2$ (robots tested in pairs)
 - b. Show that all Fast Robots can be identified with $\Theta(n)$ tests (tests done in pairs).
2. Oil marketing companies have decided to perform an analysis on crude oil prices for n number of days. The aim is to find the number of consecutive days preceding the present-day [inclusive] when the price of crude oil was not greater than the price on the present-day, for all n days. [3+3=6M]
 - a. Describe a linear time algorithm to solve the above problem using Stack ADT.
 - b. What is the time complexity of your algorithm?

Explain the logic using the example given below.

Ex.: **Input**

Day	Oil Price
Day6	110
Day5	150
Day4	120
Day3	35
Day2	34
Day1	40

Ex: **Output**

Day	Number of days
Day6	1
Day5	5
Day4	4
Day3	2
Day2	1
Day1	1

3. The Level order traversal of a Max heap is: 25, 21, 22, 15, 12, 20, 17, 13, 11, 10, 9, 19, 18, 14, 7, 4. Two new elements 23 and 16 are inserted into the heap respectively. For the new heap. [2+2=4M]
- Give the Level order traversal.
 - Give the Post order traversal.

4. BITS WILP has thousands of students admitted to its program – ‘MBA in Mass Communication’. For providing any information / notice to students BITS decides to follow a unique communication system. BITS WILP decides to create network of students in the following way –

- One Student Representative (SR) is selected.
- BITS distribute phone numbers of the students in such a way that every student is given the phone number of one other student, except for one student. This distribution of phone numbers makes sure that every student can connect to one and only one of their classmates.
- One student will not get the phone number of any of his/ her classmates (can be considered as the last student in the batch). This student will not have any phone number of his / her classmate but instead his phone number will be with one of his classmates.
- If BITS need to communicate any information / notice to the students then this notice is only provided to the SR then SR forwards it to the student ‘x’ whose phone number was distributed to him/her and then this student ‘x’ forwards it to next one student ‘y’ and this continues until it reaches the last student who doesn’t have any other student’s phone number.

Give the best Data Structure that suits the above requirement w.r.t space. Discuss the pros and cons of it. [3M]

5. Judge Jasti has created a web site that allows people to file complaints about one another. Each complaint contains exactly two names: that of the person who filed it and that of the person he/she is complaining about. Jasti had hoped to resolve each complaint personally, but the site has received so many complaints that she has realized she wants an automated approach. She decides to try to label each person as either good or evil. She only needs the labeling to be consistent, not necessarily correct. A labelling is consistent if every complaint label one person as good and the other person as evil, and no person gets labeled both as good and evil in different complaints
- Complaints propose a way to model the consistent labeling problem as a graph problem. [2M]

- b. Later, Judge Jasti wants to be more thorough. She will interview some people to figure out who is good and who is evil. She can always determine whether a person is good or evil by interviewing him or her. Assuming that one person in every complaint is good and the other is evil, what is the minimum number of people in every complaint is good and the other is evil, what is the minimum number of people she needs to interview to correctly classify all the people named in the complaints? [2M]
6. Suppose we model Arkut users with the following graph representation. An undirected. Unweighted adjacency list where vertices are users and edges represent 'friend' relationships. Thus, if two users are friends, then we have an edge between those two users.
- How would you find a person with the most friends in the networks? State the runtime of your solution. [2M]
 - The company wants to introduce a new metric for each user called network size. The network size of a user u is the number of users v such that $u \rightarrow v$, i.e., there is a path from u to v . Describe how you would calculate network size for a user u . State the runtime of your solution. [3M]
7. Consider the following sequence of (key, value) pairs, which defines a map, and a hash code for each key. Assume these entries are put into a hash table with following hash function: $h(i) = (2i+5) \bmod 10$.
- ("c", "cal") 79
 - ("D", "doug") 53
 - ("B", "bob") 88
 - ("A", "abe") 59
 - ("F", "fred") 71
 - ("E", "ed") 8
 - ("G", "greg") 20
- Draw the resulting hash tables for the case of: Open hashing (using a linked list in each bucket to handle collisions). [4M]

###All the best ###