BINUS University

Academic Career: ***Undergraduate / ~~Master~~ / ~~Doctoral~~ *)***			**Class Program:** ***~~International~~/Regular/~~Smart Program~~/~~Global Class~~*)***		
☐ **Mid Exam** ☑ **Final Exam** ☐ **Short Term Exam** ☐ **Others Exam : _____**			**Term : ~~Odd~~/Even/~~Short~~ *)**		
☑ **Kemanggisan** ☑ **Alam Sutera** ☑ **Bekasi** ☐ **Senayan** ☐ **Bandung** ☐ **Malang**			**Academic Year :** **2020 / 2021**		
Faculty / Dept.	:	School of Computer Science	Deadline	Day / Date :	Friday / July 16th, 2021
				Time :	13:00 – 16:20 (200 Minutes)
Code - Course	:	COMP6048 - Data Structures	Class	:	All Classes
Lecturer	:	Team	Exam Type	:	Online
*) *Strikethrough the unnecessary items*					
The penalty for CHEATING is DROP OUT!!!					

Learning Outcomes:

LO1 : Explain the concept of data structures and its usage in Computer Science
LO2 : Illustrate any learned data structure and its usage in application
LO3 : Apply data structures using C

FINAL EXAM INSTRUCTIONS

1. There are **2 parts** in this exam, **Essay** and **Case**
2. For essay problem:
   a. The answers must be **written by hand on paper**
   b. After that, you need to **convert all the answers into 1 pdf file** and name the file using the following format: ***nim.pdf***
   c. The lecturer will not accept any answers using word processing application in order to prevent plagiarism in the last minute
3. For case problem:
   a. **The code that you submit has to be in .cpp file format** and name the file using the following format: ***nim.cpp***
4. All of your answers, **both essay (nim.pdf) and case (nim.cpp) have to be zipped** and submitted to the **htpps://exam.apps.binus.ac.id/**. The submission through other app will not be accepted for any reasons. (**Note: please zip both files using the following format: *nim.zip***)
5. **The exam will be marked as 0 if any plagiarism is found**.
6. **The total duration of this exam is 200 minutes**, including the time for downloading the problem and uploading your answers. Please use the time provided wisely.

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I. Essay (50%)

1. [LO 1, LO 2, 20 points] Red Black Tree

a. [10 points] Given Red Black Tree in figure 1.

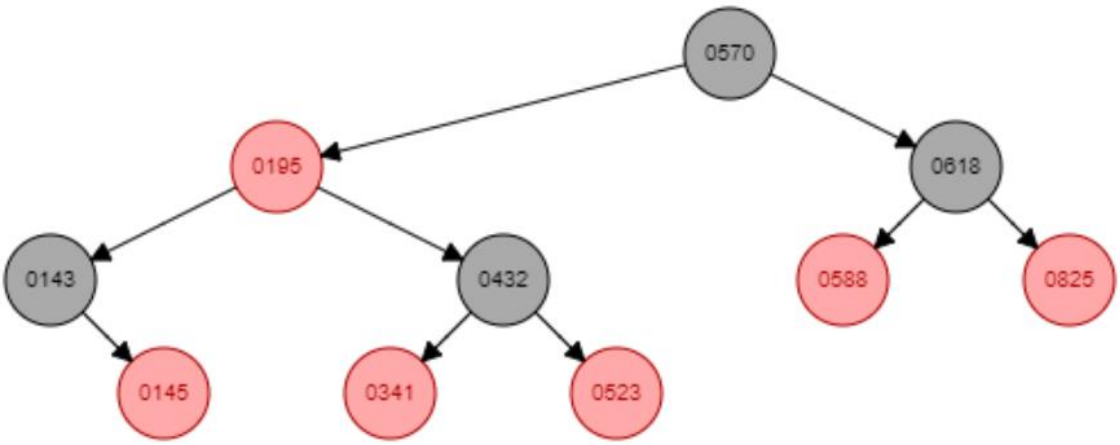

Figure 1. Red Black Tree (Insert)

Simulate the process of Red-Black Tree (Figure 1) to insert sequentially, by the following data: 555, 130, 135, 133, 140

b. [10 points] Given Red Black Tree in figure 2.

Figure 2. Red Black Tree (Delete)

Simulate the process of Red-Black Tree (Figure 2) to delete sequentially, by the following data: 281, 565, 697, 248, 723

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2. [LO 1, LO 2, 20 points] 2-3 Tree

a. **[10 points]** Given 2-3 Tree in figure 3.

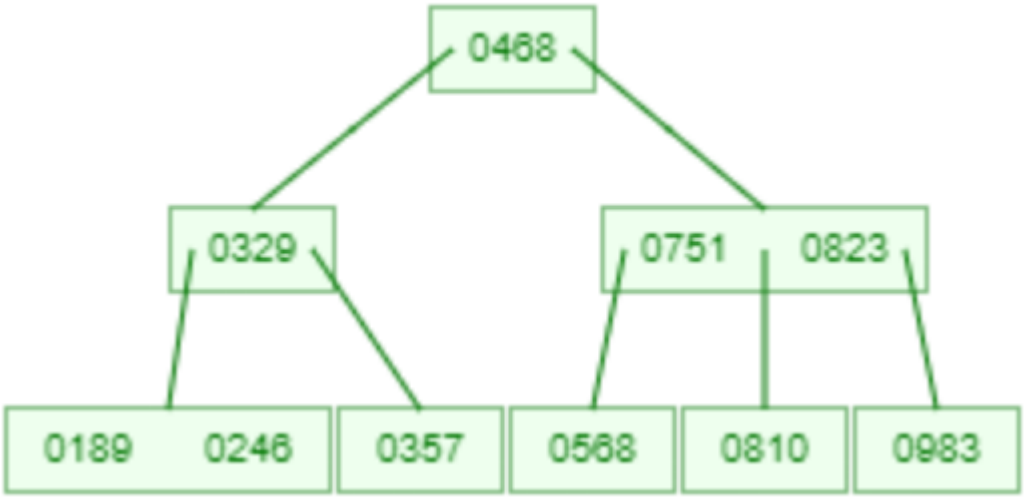

Figure 3. 2-3 Tree (Insert)

Simulate the process of 2-3 Tree (Figure 3) to insert sequentially, by the following data: 311, 400, 450, 999, 988

b. **[10 points]** Given 2-3 Tree in figure 4.

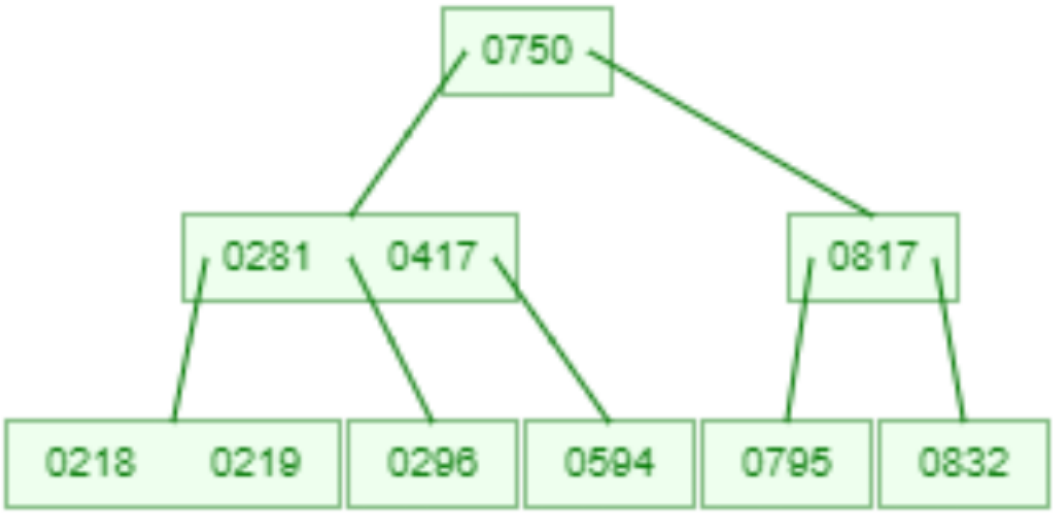

Figure 4. 2-3 Tree (Delete)

Simulate the process of 2-3 Tree (Figure 4) to delete sequentially, by the following data: 750, 219, 281, 795, 832

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3. **[LO 1, LO 2, 10 points]** Transform the graph in figure 5 below into Minimum Spanning Tree form using Prim's Algorithm ***source from G***, please answer it by using simulation table and process step given in table 1!

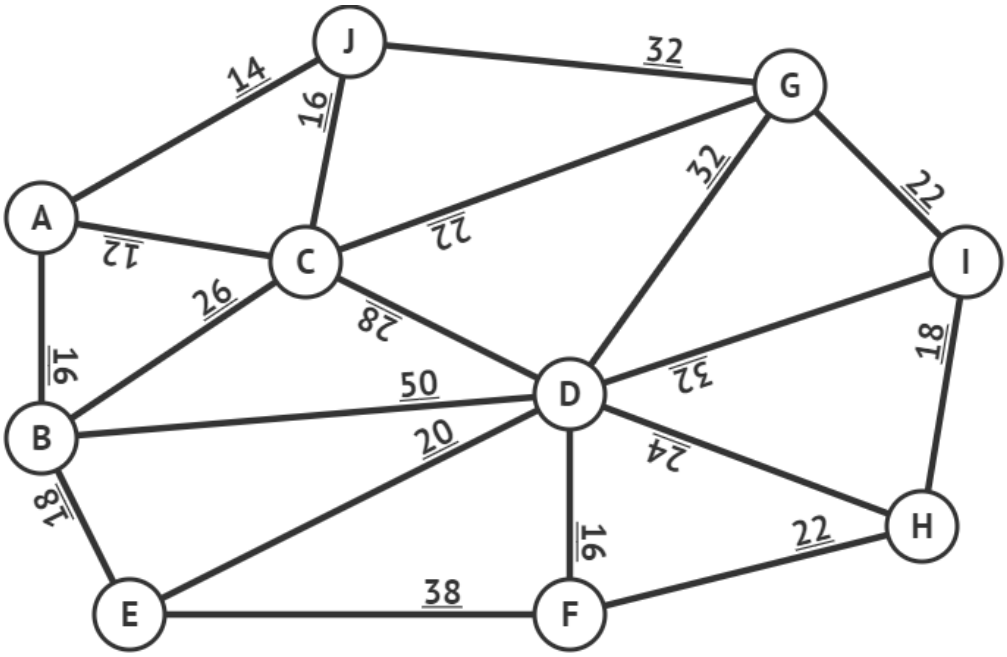

Figure 5. Graph

Table 1. Node Simulation

Adjacency List	PQ	Track	Visited

II. Case [50%]

1. **[LO 1, LO 2, LO 3, 50 points] E-DICTIONARY** is a digital language dictionary that enable the user to choose various languages in the world. As the administrator, you are asked to create a prototype developed using **AVL Tree concept** to make it easier to find the word you want to search. The prototype will be developed using the **C programming language** and all input-output operations will be done **via console.**

   Input Format:
   The first line consists of an integer T, which represents the number of test cases.
   For each test case consist of 5 types of operation (ADD, SHOW-ALL, SHOW-LANG, DEL-LANG, DEL-WORD):

1. Operation **ADD** is used to add more words to the E-DICTIONARY. This operation can be used with format "**ADD [Language] [Word]**". Ex: ADD Indonesia Makan
2. Operation **SHOW-ALL** is used to show all words in the E-DICTIONARY grouped by the language. To use this operation, the user only have to type "**SHOW-ALL**".
3. Operation **SHOW-LANG** is used to show all words in the specific language inputted by the user. This operation can be used with format "**SHOW-LANG [Language]**". Ex: SHOW-LANG Indonesia
4. Operation **DEL-LANG** is used to delete all words of the language inputted by the user. This operation can be used with format "**DEL-LANG [Language]**". Ex: DEL-LANG Indonesia
5. Operation **DEL-WORD** is used to delete specific word of the selected language inputted by the user in the E-DICTIONARY. This operation can be used with format "**DEL-WORD [Language] [Word]**". Ex: DEL-WORD Indonesia Makan

Output Format:

For each test case, start with the format "**Case X:**" where X is the test case number started from 1.
For the next line, if the operation typed by the user is:

1. "**ADD**" operation, then print "Successfully Added**"**
2. "**SHOW-ALL**" operation, then print all words in the dictionary grouped by the language with format:
   [Language] ([Total Words]):
   - [Words]

   Both the language and words are sorted in ascending order
3. "**SHOW-LANG**" operation, then print all the words in the specific language inputted by the user format:
   [Language]([Number of Words]):
   - [Word]

   Where the words are sorted in ascending order
   If the language is not found, print "[Language] language not found". Ex: Indonesia language not found
4. "**DEL-LANG**" operation, then delete selected language including all words in it. Make sure all words in the selected language are deleted then print "Successfully Deleted"
   If the language is not found, print "[Language] language not found". Ex: Indonesia language not found
5. "**DEL- WORD**" operation, then delete the specific word based on the selected language, then print "Successfully Deleted". If word is not found, print "Word ([Word]) not found". Ex: Word (Makan) not found.

Constraints:

- $1 \leq T < 2^{31}-1$
- Length of the operation is between 1 and 12 (inclusive). Operation consists of Latin alphabets. It is guaranteed that characters are not whitespaces.
- Length of the language is between 1 and 30 (inclusive). Language consists of Latin alphabets and whitespaces. It is guaranteed that the first and last characters are not whitespaces.
- Length of the word is between 1 and 50 (inclusive). Word consists of Latin alphabets and whitespaces. It is guaranteed that the first and last characters are not whitespaces.

Sample Input	Sample Output
19 **ADD English Park** **ADD English Choose** **ADD Indonesia Duduk**	**Case 1:** **Successfully Added** **Case 2:** **Successfully Added**

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ADD Indonesia Makan **ADD Spanish Medico** **ADD English Chalk** **ADD Indonesia Minum** **ADD French Cuisinier** **SHOW-ALL** **SHOW-LANG Indonesia** **DEL-LANG Indonesia** **SHOW-ALL** **ADD Indonesia Masak** **SHOW-ALL** **DEL-WORD English Choose** **DEL-WORD English Park** **DEL-WORD English Eat** **SHOW-ALL** **SHOW-LANG JAPAN**	**Case 3:** **Successfully Added** **Case 4:** **Successfully Added** **Case 5:** **Successfully Added** **Case 6:** **Successfully Added** **Case 7:** **Successfully Added** **Case 8:** **Successfully Added** **Case 9:** **English (3):** **- Chalk** **- Choose** **- Park** **French (1):** **- Cuisinier** **Indonesia (3):** **- Duduk** **- Makan** **- Minum** **Spanish (1):** **- Medico** **Case 10:** **Indonesia (3):** **- Duduk** **- Makan** **- Minum** **Case 11:** **Succesfully Deleted** **Case 12:** **English (3):** **- Chalk** **- Choose** **- Park** **French (1):** **- Cuisinier** **Spanish (1):** **- Medico** **Case 13:** **Successfully Added** **Case 14:** **English (3):** **- Chalk** **- Choose** **- Park** **French (1):** **- Cuisinier** **Indonesia (1):**

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	- Masak **Spanish (1):** **- Medico** **Case 15:** **Succesfully Deleted** **Case 16:** **Succesfully Deleted** **Case 17:** **Word (Eat) not found** **Case 18:** **English (1):** **- Chalk** **French (1):** **- Cuisinier** **Indonesia (1):** **- Masak** **Spanish (1):** **- Medico** **Case 19:** **JAPAN language not found**

-- Good Luck --

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