**CS211 – Data Structures**

Time: 80 Minutes | Final Exam – August 12, 2020 | Total Marks: 50

**Important! Read all the instructions.**

- Be honest! Do the exam yourself!
- This exam has 5 parts. Each part has a specific time duration. Each part has to be solved and submitted in its specified time duration. Parts submitted late will not be considered.
- All the paper must be solved on clean sheets, you are not allowed to type the solution.
- On top of each answer sheet, put your ID, name, signature, and page number (1, 2, 3, …).
- If you have read the instructions, draw a circle at the top right corner of the first sheet. You'll get 1 mark for it.
- Submit your solution through WhatsApp.

## Part 1 – (5 minutes)

**Q1:** In this question, a sequence of numbers is given in front of your name. You will use these numbers in the given order for solving the whole paper.

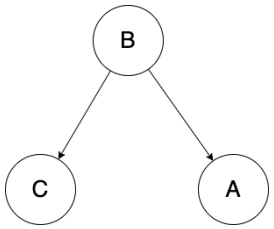
a. Write down the sum of first three numbers written in front of your name. {1}

| ID | Name | Numbers |
|---|---|---|
| 1071911001 | Rashid Ali | 8,5,2,9,4,6,7,3,1 |
| 1071911009 | Nadia Khan | 9,6,5,1,2,3,7,8,4 |
| 1071911018 | Sajjad Akbar | 4,9,3,1,6,2,7,5,8 |
| 1071911022 | Javeria Tahir | 2,4,7,5,1,9,6,8,3 |
| 4071613015 | Abdullah B Saeed | 1,6,7,8,2,4,9,5,3 |
| 4071613018 | Hamza Ahmad | 2,3,8,9,5,1,7,4,6 |
| 4071613029 | M. Awais Shehzad | 4,5,8,7,2,1,3,6,9 |
| 4071613040 | Talha Shahzad | 1,6,2,9,8,5,4,3,7 |
| 4071713002 | Huriza Farid | 2,9,8,5,4,1,3,6,7 |
| 4071713005 | Ibadullah Kahttana | 8,2,9,6,3,5,7,4,1 |
| 4071713017 | Hamza Munawar | 6,7,9,8,3,1,2,5,4 |
| 4071713019 | Dawood Amjad | 2,6,9,7,3,4,8,5,1 |
| 4071713027 | M. Hanzla | 9,6,4,1,5,8,7,3,2 |
| 4071713030 | M. Umar Basharat | 2,7,3,1,4,5,9,6,8 |
| 4071713032 | Kamran Cheema | 2,7,1,3,4,8,5,9,6 |
| 4071713035 | Haroon Rasheed | 6,3,5,9,2,7,4,1,8 |
| 4071713040 | Faizan Aleem | 4,5,7,2,8,3,6,1,9 |
| 4071713044 | M. Usama Usman | 7,6,9,8,3,4,2,1,5 |
| 4071713048 | Zahra Abbas | 4,9,5,6,2,8,7,3,1 |
| 4071713050 | M. Arhum | 2,4,9,6,5,1,3,7,8 |

| ID | Name | Numbers |
|---|---|---|
| 4071713051 | Umair Sadeeq | 3,7,5,8,4,9,1,2,6 |
| 4071713052 | Hamza Irshad | 6,1,7,3,2,8,4,5,9 |
| 4071713054 | Raveena | 4,7,8,6,1,2,5,3,9 |
| 4071813001 | Minhal Ayub Vine | 5,1,9,2,7,8,3,6,4 |
| 4071813008 | Khadija Mustafa | 2,8,6,1,9,3,4,5,7 |
| 4071813009 | Shahid Khan | 3,2,6,5,9,4,1,8,7 |
| 4071813013 | M. Umer Haider | 3,2,7,4,1,6,5,9,8 |
| 4071813016 | Sania Javed | 7,4,9,2,5,1,8,6,3 |
| 4071813017 | Komal Khalil | 2,1,7,6,3,8,4,9,5 |
| 4071813018 | M. Talha Gondal | 5,8,6,2,3,7,9,1,4 |
| 4071813024 | Hamza Ali | 8,9,3,2,1,4,6,7,5 |
| 4071813027 | Syed Ahsan | 2,3,7,4,9,1,5,6,8 |
| 4071813031 | Fardah Naik | 2,3,1,6,8,7,5,9,4 |
| 4071813036 | Abdul Aziz Khan | 9,5,2,6,7,8,3,4,1 |
| 4071813040 | Hamna Naveed | 7,6,2,5,3,8,1,4,9 |
| 4071813042 | M. Aqil Shahzad | 7,6,8,5,2,9,3,1,4 |
| 4071813043 | M. Touqeer Zia | 2,4,3,7,6,5,9,8,1 |
| 4071813044 | Kashif Naeem | 8,4,1,5,3,2,6,9,7 |
| 4071813046 | M. Sheraz Rana | 4,2,6,3,8,9,7,5,1 |
| 4071813051 | Majid Ali | 6,7,2,1,4,8,5,3,9 |

## Part 2 – (25 minutes)

**Q2:** In a Reverse Binary Search Tree (RBST), the smaller values of a node are stored on its right and larger values on its left. For example, after inserting the three values: B, A, and C, the RBST will look like as shown below.




a. How an RBST would look like after inserting the values given to you in Q1? {5}

b. Similar to the RBST, in the Reverse AVL Tree (RAVL), the smaller values of a node are stored on its right and larger values on its left. How an RAVL tree would look like after inserting the values given to you in Q1? Please note that you would need to think about the rotations, as the rotations used to insert values in a simple AVL tree might not work in the RAVL tree. Show all the intermediate steps. {10}

**Part 3 – (30 minutes)**

**Q3:** In this question, you will insert the values given to you in Q1 in a hash table. For part (a), assume that the hash table already contains the following values:

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 18 | 49 | 20 | | | | | | | | | |

a. Using open addressing and double hashing with **`h1(k)=k%15`** and **`h2(k)=(k%3)+1`** in a hash table of **size 15**. {10}

b. Using chaining and multiplication method with A = 0.3. For chaining, consider a hash table of **size 4**. {5}

## Part 4 – (20 minutes)

**Q4:**

a. For the RBST you created in Q2 (a), write code to separately allocate memory for each of the nine nodes and manually link these nodes. Do not use any loops, do not call any function. Just write the code to link the nodes. {4}

b. Using just the address of the root node in part (a), write an iterative code to display all the nodes in the tree using pre-order traversal. {4}

## Part 5 – (5 minutes)

**Q5:** VIVA to be conducted through MS Teams as per the following schedule. {10}

| Sr | ID | Name | Viva |
|---|---|---|---|
| 1 | 1071911001 | Rashid Ali | 2:15 PM |
| 2 | 1071911009 | Nadia Khan | 2:10 PM |
| 3 | 1071911018 | Sajjad Akbar | 2:05 PM |
| 4 | 1071911022 | Javeria Tahir | 2:00 PM |
| 5 | 4071613015 | Abdullah Bin Saeed | 1:10 PM |
| 6 | 4071613018 | Hamza Ahmad | 1:05 PM |
| 7 | 4071613029 | M. Awais Shehzad | 1:55 PM |
| 8 | 4071613040 | Talha Shahzad | 1:50 PM |
| 9 | 4071713002 | Huriza Farid | 1:00 PM |
| 10 | 4071713005 | Ibadullah Kahttana | 12:55 PM |
| 11 | 4071713017 | Hamza Munawar | 12:50 PM |
| 12 | 4071713019 | Dawood Amjad | 12:45 PM |
| 13 | 4071713027 | M. Hanzla | 12:40 PM |
| 14 | 4071713030 | M. Umar Basharat | 1:45 PM |
| 15 | 4071713032 | Kamran Ahmed Cheema | 12:35 PM |
| 16 | 4071713035 | Haroon Rasheed | 12:30 PM |
| 17 | 4071713040 | Faizan Aleem | 12:25 PM |
| 18 | 4071713044 | M. Usama Usman | 12:20 PM |
| 19 | 4071713048 | Zahra Abbas | 12:15 PM |
| 20 | 4071713050 | M. Arhum | 12:10 PM |

| Sr | ID | Name | Viva |
|---|---|---|---|
| 21 | 4071713051 | Umair Sadeeq | 12:05 PM |
| 22 | 4071713052 | Hamza Irshad | 1:40 PM |
| 23 | 4071713054 | Raveena | 12:00 PM |
| 24 | 4071813001 | Minhal Ayub | 1:35 PM |
| 25 | 4071813008 | Khadija Mustafa | 11:55 AM |
| 26 | 4071813009 | Shahid Khan | 11:50 AM |
| 27 | 4071813013 | M. Umer Haider | 11:45 AM |
| 28 | 4071813016 | Sania Javed | 11:40 AM |
| 29 | 4071813017 | Komal Khalil | 11:35 AM |
| 30 | 4071813018 | M. Talha Gondal | 1:30 PM |
| 31 | 4071813024 | Hamza Ali | 11:30 AM |
| 32 | 4071813027 | Syed Ahsan | 11:25 AM |
| 33 | 4071813031 | Fardah Naik | 1:25 PM |
| 34 | 4071813036 | Abdul Aziz Khan | 1:20 PM |
| 35 | 4071813040 | Hamna Naveed | 1:15 PM |
| 36 | 4071813042 | M. Aqil Shahzad | 11:20 AM |
| 37 | 4071813043 | M. Touqeer Zia | 11:15 AM |
| 38 | 4071813044 | Kashif Naeem | 11:10 AM |
| 39 | 4071813046 | M. Sheraz Rana | 11:05 AM |
| 40 | 4071813051 | Majid Ali | 11:00 AM |