

University of Birmingham

*MSc Computer Science*

**Data Structures – MSc Assignment**

Assignment prepared by:

**AXT114**

**Abdikhaliq Timer**

# Question 1

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## 1(b)

The following would require maximum number of swaps:

1,2,3,4,5,6,7,8,9

# Question 2: Hash tables

## 2 (a)

A hash table with 11 slots, numbered 0 to 10, employs double hashing, skipping leftwards. A key is a 5-digit number; its primary hash code is (2nd digit + 4th digit) mod 11, and its secondary hash code is (3rd digit mod 5) +1. Initially the hash table is empty, and then the following instructions are executed.

Insert 25732

Insert 41850

Insert 27119

Delete 41850

Insert 39721

Insert 46211

Insert 32054

Delete 25732

Insert 43416

For deletion, tombstones are used. Write out the contents of the slots at the end of all these instructions. (For full marks, you don't need to write out intermediate steps, though you might find it helpful to do so.)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index (Position) | | | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| ***39721*** |  |  |  | ***27119*** |  | ***32054*** | ***46211*** | ***RIP*** |  | ***43416*** |

## 2(B)

Do you think tombstones should be included when calculating the load factor of a hash table? Justify your answer.

Yes.

The reasoning behind my answer is from the Data Structures and Algorithm Analysis book by Clifford Shaffer.

Tombstones cause lengthening of the average distance from a records home position to the record itself, going beyong where it could be if the tombstone did not exist, hence the probe sequence takes longer. The insertion cost is hence greater, hence in our calculation for the load factor, that tells us if we will need to increase the hash tables capacity, it is important to include tombstones.

## Q3

Are the graphs planar (and why)?

### Graph A:

Graph A has K5 through ACTSL. Hence it is **not planar**.

### Graph B:

Graph B is **planar** as it does not have **K5** or **K3,3** structures within it.

## Q4

What are Fred’s estimated path lengths to F, to G and to H?

Estimated path lengths:

* To F = 8.
  + From tight node E. Hence, A to E ; 3 + 4, E to F; 7 + 1 = 8
* To G = 10
  + Again, coming from tight node E. Hence, A to E; 3 + 4, to G; 7 + 3 = 10. As we are not using Dijkstra’s algorithm, F will not become a tight node.
* To H = 12
  + Tight node B to H (6 + 6 = 12).