

## 2008 Paper 10 Question 9

### Data Structures and Algorithms

- (a) Take an initially empty hash table with five slots, with hash function  $h(x) = x \bmod 5$ , and with collisions resolved by chaining. Draw a sketch of what happens when inserting the following sequence of keys into it: 35, 2, 18, 6, 3, 10, 8, 5.  
[You are not requested to draw the intermediate stages as separate figures, nor to show all the fields of each entry in detail.] [3 marks]
- (b) Repeat part (a) but with the following three changes: the hash table now has ten slots, the hash function is  $h(x) = x \bmod 10$ , and collisions are resolved by linear probing. [3 marks]
- (c) Imagine a hash table implementation where collisions are resolved by chaining but all the data stays within the slots of the original table. All entries not containing key–value pairs are marked with a Boolean flag and linked together into a free list.
- (i) Give clear explanations on how to implement the `set(key, value)` method in expected constant time, highlighting notable points and using high-level pseudocode where appropriate. Make use of doubly-linked lists if necessary. [8 marks]
- (ii) Assume the hash table has 5 slots, is initially empty and uses the hash function  $h(x) = x \bmod 5$ . Draw five diagrams of the hash table representing the initially empty state and then the table after the insertion of each of the following key–value pairs: (2, A), (2, C), (12, T), (5, Z). In the final diagram, draw all the fields and pointers of all the entries. [6 marks]