EE2008 Homework Assignment #1

Name: _____

Tutorial group: _____

Matriculation number: _____

1. Suppose that a hash table is created by hashing a set of keys using the hash function $h(x) = (x \bmod \alpha)$, where α denotes the number of items the hash table consists of. Depending on your matriculation number, the value of α will vary. First, **multiply** the digits in your matriculation number. If this **product value** ends between 0 and 1, $\alpha = 7$; if between 2 and 5, $\alpha = 11$; else if between 6 and 9, $\alpha = 13$. Please refer to the hash table below that corresponds to the value of α pertaining to your matriculation number.

$\alpha = 7$

S/N	key
0	987
1	36
2	51
3	52
4	228
5	109
6	46

$\alpha = 11$

S/N	key
0	54
1	132
2	43
3	617
4	
5	
6	369
7	226
8	
9	
10	318

$\alpha = 13$

S/N	key
0	103
1	65
2	90
3	
4	
5	96
6	200
7	421
8	
9	
10	
11	
12	207

(a) List down the order (sequence) of the keys in which the hash table would have resulted assuming that the collisions were handled by linear probing. Please declare the product value of your matriculation number and the corresponding α before working out the solution. **Please note that unlike the lecture notes or tutorial which requires you to construct the hash table given the sequence of keys, this question works in the reverse (i.e., given the hash table, what would have been the original sequence of keys?) This question has multiple correct solutions.**

(20 marks)

(b) For this given order of keys that you have derived for (a), how would you draw the hash table if the collisions were instead handled by double hashing using a second hash function $d(x) = \beta - (x \bmod \beta)$? For those who used $\alpha = 7$, please use $\beta = 5$; if you had $\alpha = 11$, then $\beta = 7$; else if your $\alpha = 13$, $\beta = 11$. Please declare the β first before working out the solution.

(20 marks)

2. You are required to address a problem that again depends on your matriculation number. First, **add** the digits in your matriculation number. If this **sum value** ends between 0 and 3, solve (a); if between 4 and 6, solve (b) with `m = 8`; else if between 7 and 9, solve (b) with `m = 9`. Please declare the sum value first before working out the solution.

   (a) A **queue** is an abstract data type (ADT) with 5 basic functions, including `queue_init()`, `empty()`, `enqueue(val)`, `dequeue()`, and `front()`, where `val` is a data item. The detailed construction of these functions is not specified for the ADT. Using the basic functions of the queue, write a function `maxVal(q)` to find the maximum value contained in a non-empty queue `q`. Before and after the execution of `maxVal(q)`, the content of `q` should remain unchanged. You may use additional queues to accomplish the task.

   (b) Consider the following recursive algorithm. Determine the output of the printing process. Justify the printed output in detail.

```
Algorithm test(m) {
  if (m == 0) or (m == 1)
    return 1
  else {
    print(m + " ")   // output m + space
    result = 2*test(m - 2)
    print(result + " ")  // output result + space
    return m*result
    print(m*result + " ")  // output result + space
  }
}
// The symbol "+" in print will not be printed.
// "+" means and in this case
```

(30 marks)

3. Solve one of the mathematical induction proofs based on your matriculation number. If your **matriculation number** ends between 0 and 2, solve (a); if between 3 and 5, solve (b); else if between 6 and 9, solve (c).

   (a) Prove that $8^n > (2n-1)^2$ for $n \in \mathbb{Z}, n > 2$

   (b) Prove that $(n+1)! > 3^n$ for $n \in \mathbb{Z}, n \geq 4$

   (c) Prove that $n^4 + 3$ is divisible by 4 for $n \in \mathbb{Z}, n \geq 1, n$ is an odd number

(30 marks)