Tutorial 08: Mar 11

1. **Insert with probing**
   Consider a hash table of size 7. For each of the scenarios below, insert the keys $14, 10, 20, 13, 7, 17$, then delete 14 and search for 13.

   (a) Linear Probing with $h(k) = k \bmod 7$.

   (b) Double Hashing with $h_0(k) = k \bmod 7$ and $h_1(k) = (k \bmod 5) + 1$.

2. **Cycle in Cuckoo Hashing**
   Assume $M = 5$, $U = \{0, 1, 2, \ldots, 23, 24\}$ and suppose we are given following hash functions.

   $$h_0(k) = k \bmod 5$$
   $$h_1(k) = \lfloor \tfrac{k}{5} \rfloor \bmod 5$$

   Find a scenario where we end up with infinite loop after calling an `insert` (assume that our "emergency break" of $2n$ iterations does not exist) in Cuckoo Hashing. To be more specific, come up with the keys that are in each table and find a newly inserted key that will cause infinite loop.

3. **Data structure design**
   Design a dictionary data structure to store key-value-pairs with uniformly distributed integer keys such that the operations for search, insert, and delete have $O(\log n)$ runtime and $O(1)$ expected runtime.