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These problems were given on exams for this course. Some older problems did not make use of generics in Java, but generic implementations are now required in this course.

**Problem 1** (a) Assume that a chained hash table is implemented with the following instance variables.

```
public class ChainedHashTable<K, V> implements Map<K, V> {
    int size;
    int capacity;
    ArrayList<Pair<K, V>> bucket[];
    // method implementation code omitted
}
```

Write a Java implementation for the method *get*

**Answer:**

(b) Consider these three possibilities for a hash function to be applied to String data (representing words in text). The data is to be stored in a chained table with capacity 20. For each function either describe any reason(s) why it would not work well or state that it is a good choice.

(i) The function converts the first character in the String to lower case and returns its ASCII code modulo 20.

**Answer:**

(ii) The function generates a random number  $x$  that indexes a position in the String. It then converts character number  $x$  in the String to lower case and returns its ASCII code modulo 20.

**Answer:**

(iii) The function converts all characters in the String to lower case and returns the sum of their ASCII codes.

**Answer:**

**Problem 2** The generic class ChainedHashTable has the following partial implementation.

```
public class ChainedHashTable<K, V> implements Map<K, V> {
    int size;
    int capacity;
    ArrayList<Pair<K, V>> bucket[];

    ChainedHashTable(int cap) {
        capacity = cap;
        bucket = (ArrayList<Pair<K, V>>[]) new ArrayList[cap];
        size = 0;
        for (int i = 0; i < cap; i++)
            bucket[i] = null;
    }

    // standard methods omitted
}
```

**Give a complete implementation** of a standard method called *put*. Assume that the class  $K$  has a useful method called *hash* that returns a positive integer result.

**Give a complete implementation** of a non-standard method called *loadFactor* that returns the average number of elements in each bucket.

**Problem 3** (a) Describe the instance variables that are used to store and implement a hash table that uses open addressing and linear probing. (Give Java declarations for the instance variables.)

(b) Using the instance variables that you gave in (a), implement the methods `public void insert(K k, V x)` and `V find(K k)`.