PROBLEM SOLUTION APPROACH

PART 1

I designed my own HashMap that implements KWHashMap using HashTableChain. I wrote the MapIterator class into this class.
MapIterator implements the Iteretor interface that I wrote myself.

Since the indexes of the values in HashMap are placed according to the Hashing rule (since they are not sequential), I have determined that I need to write the methods of the Iterator class accordingly.

HashNext method should proceed up to the index value of the last key in HashMap. Nullable key values should be omitted.

Next method should check if HashMap is empty and retract the next one from the last key value.

The prev method should check if HashMap is empty and retract the one before the last key value.

In the MapIterator (K key) constructor, the received key value should be considered as a starting point. If the given key is not in HashMap, I designed it so that it will start from the beginning.

PART 2

In the first part requested, I got the necessary class structure and its methods from the book. I added exception Handling where necessary. I realized that I need to create a chain structure using LinkedList.

In the second requested part, I realized that I had to create the HashTableChain structure that I created with LinkedList using TreeSet. And for this, I implements Comperable to the structure I designed in the first part to compare TreeSet.

In the third desired part, I understood that quadratic probing should be investigated thoroughly.And in order to do add and remome methods, I had to learn this logic thoroughly and I used open addressing for this method.For the add method, I found it appropriate to place elements in the table with the hash method, but if there is another element where an element is added, I used quadratic probing and determined the next accordingly.In the remove method, I understood that if the key to be removed has a next, it should be seted by the extracted element, but I realized that it should continue with a row in the table and as a result, I would design my method.

Test Cases / Running Command and Results

PART1

```
File  Edit  View  Search  Terminal  Help
yunus@yunus-Lenovo-V330-15IKB:~/Desktop/HM5$ make
javac *.java && java Main
HashMap b :
İngiltere => Londra
Fransa => Paris
Almanya => Berlin
Portekiz => Porto
Türkiye => Ankara
İspanya => Madrid
--------------------------------------------------------------------------------

--- With Iterator HashMap b (Begin Fransa key) (itr) ---
Fransa
Almanya
Portekiz
Türkiye
İspanya
--------------------------------------------------------------------------------

--- Prev method applied for 6 position from the last cursor position(İspanya) ---
 Cursor back to İspanya key again with using prev method (itr)
--- Prev Method For b HashMap ---
Türkiye
Portekiz
Almanya
Fransa
İngiltere
İspanya
--------------------------------------------------------------------------------

--- With Iterator HashMap b (Begin initial key) (itr5) ---
İngiltere
Fransa
Almanya
Portekiz
Türkiye
İspanya
--------------------------------------------------------------------------------

--- Before the put element to b3 HashMap ---
if there are still not-iterated key/s in the Map, otherwise returns False :
false
--------------------------------------------------------------------------------

HashMap b3 :
1 => 101
--------------------------------------------------------------------------------

It returns the first key when there is no not-iterated key in the Map (itr3) :
1
--------------------------------------------------------------------------------

HashMap b3 :
1 => 101
2 => 102
3 => 103
4 => 104
5 => 105
6 => 106
```

```
File  Edit  View  Search  Terminal  Help

HashMap b3 :
1 => 101
2 => 102
3 => 103
4 => 104
5 => 105
6 => 106
7 => 107
--------------------------------------------------------------------------------------------------

It returns the last key when the iterator(itr6) is at the first key :
7
--------------------------------------------------------------------------------------------------

--- With Iterator(itr4) HashMap b3 (Begin 4 key) ---
4
5
6
--------------------------------------------------------------------------------------------------

For Empty HashMap b2:
--- Exception Handling For HashMap ---
--------------------------------------------------------------------------------------------------
!!! The HashMap is empty, Please insert an element before the next method !!!
ClassException
--------------------------------------------------------------------------------------------------
--- After Prev Method For b2 HashMap ---
!!! The HashMap is empty, Please insert an element before the prev method !!!
ClassException
--------------------------------------------------------------------------------------------------
--- After Prev Method For b2 HashMap ---
!!! The Hashmap is empty, Please insert an element before the get method !!!
ClassException

--------------------------------------------------------------------------------------------------
----------------------------------------HashTableChain--------------------------------------------
----------------------------------------With LinkedList-------------------------------------------

------ HashTableChain With LinkedList ------
------ METHOD TESTING ------
--------------------------------------------------------------------------------------------------
İstanbul(Key) is being put and its value : 34
İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24

--------------------------------------------------------------------------------------------------
Size of the HashTable :8
--------------------------------------------------------------------------------------------------
HashTable is mpty ? :false
--------------------------------------------------------------------------------------------------

if the key does not exits in the HashTableChain :
```

PART 2 - HashTableChain With LinkedList

Method Testing

```
File  Edit  View  Search  Terminal  Help

--------------------------------------------------------------------------------------------------------
-----------------------------------------HashTableChain-------------------------------------------------
-----------------------------------------With LinkedList------------------------------------------------

------ HashTableChain With LinkedList ------
------ METHOD TESTING ------
--------------------------------------------------------------------------------------------------------
İstanbul(Key) is being put and its value : 34
İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24

--------------------------------------------------------------------------------------------------------
Size of the HashTable :8
--------------------------------------------------------------------------------------------------------
HashTable is mpty ? :false
--------------------------------------------------------------------------------------------------------

if the key does not exits in the HashTableChain :
Muğla(Key) is being Remove and its value : null
--------------------------------------------------------------------------------------------------------

İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24

--------------------------------------------------------------------------------------------------------
İzmir(Key) is being Remove and its value : 35

İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
Bolu => 14 İndex :24
--------------------------------------------------------------------------------------------------------

For Empty HashTableChain a2:
--- Exception Handling For HashTableChain With LinkedList ---
!!! The HashTableChain is empty, Please insert an element before the remove method !!!
ClassException

--------------------------------------------------------------------------------------------------------
!!! The HashTableChain is empty, Please insert an element before the get method !!!
ClassException
--------------------------------------------------------------------------------------------------------
----------------- PERFORMANCE TESTING -----------------
```

Performance Testing

```
File  Edit  View  Search  Terminal  Help
İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24

--------------------------------------------------------------------------------------------------
İzmir(Key) is being Remove and its value : 35

İstanbul => 37 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
Bolu => 14 İndex :24
--------------------------------------------------------------------------------------------------

For Empty HashTableChain a2:
--- Exception Handling For HashTableChain With LinkedList ---
!!! The HashTableChain is empty, Please insert an element before the remove method !!!
ClassException

--------------------------------------------------------------------------------------------------
!!! The HashTableChain is empty, Please insert an element before the get method !!!
ClassException
--------------------------------------------------------------------------------------------------
---------------- PERFORMANCE TESTING ----------------

--------------------------------------------------------------------------------------------------
1) TEST WITH SMALL SIZE
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For put Method Operation Time:24508
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For get Method Operation Time:123338
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For remove Method Operation Time:74101

--------------------------------------------------------------------------------------------------
1) TEST WITH MEDIUM SIZE
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For put Method Operation Time:355025
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For get Method Operation Time:2377772
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For remove Method Operation Time:361402

--------------------------------------------------------------------------------------------------
1) TEST WITH LARGE SIZE
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For put Method Operation Time:1677923
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For get Method Operation Time:74771043
--------------------------------------------------------------------------------------------------
HashTable Chain with LİnkedList For remove Method Operation Time:9159289
```

PART 2 - HashTableChain With TreeSet
Method Testing

```
File  Edit  View  Search  Terminal  Help

--------------------------------------------------------------------------------------------------------
-----------------------------------------HashTableChain-------------------------------------------------
-----------------------------------------With TreeSet---------------------------------------------------

--- HashTableChain With TreeSet ---
------ METHOD TESTING ------
--------------------------------------------------------------------------------------------------------
İstanbul => 34 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24

--------------------------------------------------------------------------------------------------------
Size of the HashTable :8
--------------------------------------------------------------------------------------------------------
HashTable is mpty ? :false
--------------------------------------------------------------------------------------------------------

if the key does not exits in the HashTableChain :
Karaman(Key) is being Remove and its value : null
--------------------------------------------------------------------------------------------------------

İstanbul => 34 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24
--------------------------------------------------------------------------------------------------------

Bolu(Key) is being Remove and its value : 14
--------------------------------------------------------------------------------------------------------

İstanbul => 34 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
--------------------------------------------------------------------------------------------------------

--- Exception Handling For HashTableChain With TreeSet ---
!!! The HashTableChain is empty, Please insert an element before the remove method !!!
ClassException
--------------------------------------------------------------------------------------------------------

!!! The HashTableChain is empty, Please insert an element before the get method !!!
ClassException
--------------------------------------------------------------------------------------------------------
----------------- PERFORMANCE TESTING -----------------
```

Performance Testing

```
File  Edit  View  Search  Terminal  Help
İstanbul => 34 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
Bolu => 14 İndex :24
-------------------------------------------------------------------------------------------------

Bolu(Key) is being Remove and its value : 14
-------------------------------------------------------------------------------------------------

İstanbul => 34 İndex :1
Adana => 1 İndex :4
Edirne => 22 İndex :8
Kocaeli => 41 İndex :10
Çankırı => 18 İndex :13
Çorum => 19 İndex :16
İzmir => 35 İndex :21
-------------------------------------------------------------------------------------------------

--- Exception Handling For HashTableChain With TreeSet ---
!!! The HashTableChain is empty, Please insert an element before the remove method !!!
ClassException
-------------------------------------------------------------------------------------------------

!!! The HashTableChain is empty, Please insert an element before the get method !!!
ClassException
-------------------------------------------------------------------------------------------------
---------------- PERFORMANCE TESTING ----------------

-------------------------------------------------------------------------------------------------
1) TEST WITH SMALL SIZE
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For put Method Operation Time:34425
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For get Method Operation Time:345162
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For remove Method Operation Time:146944

-------------------------------------------------------------------------------------------------
1) TEST WITH MEDIUM SIZE
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For put Method Operation Time:492901
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For get Method Operation Time:5033012
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For remove Method Operation Time:590841

-------------------------------------------------------------------------------------------------
1) TEST WITH LARGE SIZE
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For put Method Operation Time:1912967
-------------------------------------------------------------------------------------------------
ashTable Chain with TreeSet For get Method Operation Time:35484656
-------------------------------------------------------------------------------------------------
HashTable Chain with TreeSet For remove Method Operation Time:4546653
```

PART 2 - HashTableOpen With Coalesced Hashing Technique Method Testing

```
File  Edit  View  Search  Terminal  Help
--------------------------------------------------------------------------------------------
-----------------------------------------HashTableOpen--------------------------------------
------------------------------- With Coalesced Hashing Technique-----------------------------

--------------------------------------------------------------------------------------------
--- HashTableOpen Coalesced Hashing Technique ---

------ METHOD TESTING ------
51 => 105 İndex :1 next :null
12 => 101 İndex :2 next :6
3 => 100 İndex :3 next :4
13 => 102 İndex :4 next :7
25 => 103 İndex :5 next :null
42 => 106 İndex :6 next :null
23 => 104 İndex :7 next :null

--------------------------------------------------------------------------------------------
Number of HashTableOpen :7

--------------------------------------------------------------------------------------------
--- After the Removing ---
if the key does not exits in the HashTableOpen :
1(Key) is being Remove and its value : null

--------------------------------------------------------------------------------------------

51 => 105 İndex :1 next :null
12 => 101 İndex :2 next :6
3 => 100 İndex :3 next :4
13 => 102 İndex :4 next :7
25 => 103 İndex :5 next :null
42 => 106 İndex :6 next :null
23 => 104 İndex :7 next :null

13(Key) is being Remove and its value : 102

51 => 105 İndex :1 next :null
12 => 101 İndex :2 next :6
3 => 100 İndex :3 next :4
23 => 104 İndex :4 next :null
25 => 103 İndex :5 next :null
42 => 106 İndex :6 next :null

--------------------------------------------------------------------------------------------


--------------------------------------------------------------------------------------------
--- Exception Handling For HashTableOpen Coalesced Hashing Technique ---
!!! The HashTableOpen is empty, Please insert an element before the remove method !!!
ClassException

!!! The HashTableOpen is empty, Please insert an element before the get method !!!
ClassException
--------------------------------------------------------------------------------------------
----------------- PERFORMANCE TESTING -----------------

--------------------------------------------------------------------------------------------
1) TEST WITH SMALL SIZE
--------------------------------------------------------------------------------------------
```

Performance Testing

```
File  Edit  View  Search  Terminal  Help
--------------------------------------------------------------------------------------------------------


51 => 105 İndex :1 next :null
12 => 101 İndex :2 next :6
3 => 100 İndex :3 next :4
13 => 102 İndex :4 next :7
25 => 103 İndex :5 next :null
42 => 106 İndex :6 next :null
23 => 104 İndex :7 next :null

13(Key) is being Remove and its value : 102

51 => 105 İndex :1 next :null
12 => 101 İndex :2 next :6
3 => 100 İndex :3 next :4
23 => 104 İndex :4 next :null
25 => 103 İndex :5 next :null
42 => 106 İndex :6 next :null

--------------------------------------------------------------------------------------------------------


--------------------------------------------------------------------------------------------------------
--- Exception Handling For HashTableOpen Coalesced Hashing Technique ---
!!! The HashTableOpen is empty, Please insert an element before the remove method !!!
ClassException

!!! The HashTableOpen is empty, Please insert an element before the get method !!!
ClassException
--------------------------------------------------------------------------------------------------------
----------------- PERFORMANCE TESTING -----------------

--------------------------------------------------------------------------------------------------------
1) TEST WITH SMALL SIZE
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open  For put Method Operation Time:20018
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For get Method Operation Time:10463
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For remove Method Operation Time:33372

--------------------------------------------------------------------------------------------------------
1) TEST WITH MEDIUM SIZE
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For put Method Operation Time:158712
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For get Method Operation Time:50929
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For remove Method Operation Time:696123

--------------------------------------------------------------------------------------------------------
1) TEST WITH LARGE SIZE
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For put Method Operation Time:1835748
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For get Method Operation Time:541881
--------------------------------------------------------------------------------------------------------
Coalesced HashTable Open For remove Method Operation Time:9966778
yunus@yunus-Lenovo-V330-15IKB:~/Desktop/HM5$
```