

<b>Đã bắt đầu vào lúc</b>	Thứ ba, 26 Tháng chín 2023, 11:09 AM
<b>Tình trạng</b>	Đã hoàn thành
<b>Hoàn thành vào lúc</b>	Thứ năm, 5 Tháng mười 2023, 2:57 PM
<b>Thời gian thực hiện</b>	9 ngày 3 giờ
<b>Điểm</b>	8,65/9,00
<b>Điểm</b>	<b>9,61</b> của 10,00 ( <b>96,11%</b> )

# Câu hỏi 1

Chính xác

Điểm 0,75 của 1,00

Class `LLNode` is used to store a node in a singly linked list, described on the following:

```
class LLNode {  
    public:  
        int val;  
        LLNode* next;  
        LLNode();  
        LLNode(int val, LLNode* next);  
}
```

Where `val` is the value of node, `next` is the pointer to the next node.

**Request:** Implement function:

```
LLNode* addLinkedList(LLNode* l0, LLNode* l1);
```

Where `l0`, `l1` are two linked lists represented positive integers, each node is a digit, the head is the least significant digit (the value of each node is between 0 and 9, the length of each linked list is between 0 and 100000). This function returns the linked list representing the sum of the two integers.

**Example:**

Given `l0 = [2, 3]` (representing 32) and `l1 = [1, 8]` (representing 81). The result would be `l0 = [3, 1, 1]` (representing  $32 + 81 = 113$ ).

**Note:**

In this exercise, the libraries `iostream`, `string`, `cstring`, `climits`, `utility`, `vector`, `list`, `stack`, `queue`, `map`, `unordered_map`, `set`, `unordered_set`, `functional`, `algorithm` has been included and `namespace std` are used. You can write helper functions and classes. Importing other libraries is allowed, but not encouraged, and may result in unexpected errors.

**For example:**

Test	Result
<pre> int arr1[] = {2, 9}; int arr2[] = {0, 5}; LLNode* head1 = LLNode::createWithIterators(arr1, arr1 + sizeof(arr1) / sizeof(int)); LLNode* head2 = LLNode::createWithIterators(arr2, arr2 + sizeof(arr2) / sizeof(int)); LLNode* newhead = addLinkedList(head1, head2); LLNode::printList(newhead); head1-&gt;clear(); head2-&gt;clear(); newhead-&gt;clear(); </pre>	[2, 4, 1]

**Answer:** (penalty regime: 0, 0, 0, 5, 10, ... %)

Reset answer

```

1 ▼ LLNode* addLinkedList(LLNode* l0, LLNode* l1) {
2     LLNode* dummyHead = new LLNode();
3     LLNode* current = dummyHead;
4     int carry = 0;
5
6 ▼     while (l0 || l1) {
7         int sum = carry;
8 ▼         if (l0) {
9             sum += l0->val;
10            l0 = l0->next;
11        }
12 ▼         if (l1) {
13             sum += l1->val;
14             l1 = l1->next;
15        }
16
17        carry = sum / 10;
18        current->next = new LLNode(sum % 10, nullptr);
19        current = current->next;
20    }
21
22 ▼    if (carry > 0) {

```

	Test	Expected	Got	
✓	<pre> int arr1[] = {2, 9}; int arr2[] = {0, 5}; LLNode* head1 = LLNode::createWithIterators(arr1, arr1 + sizeof(arr1) / sizeof(int)); LLNode* head2 = LLNode::createWithIterators(arr2, arr2 + sizeof(arr2) / sizeof(int)); LLNode* newhead = addLinkedList(head1, head2); LLNode::printList(newhead); head1-&gt;clear(); head2-&gt;clear(); newhead-&gt;clear(); </pre>	[2, 4, 1]	[2, 4, 1]	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00. Tính toán cho lần làm bài trước đó, điểm **0,75/1,00**.

## Câu hỏi 2

Chính xác

Điểm 1,00 của 1,00

**Polynomials** is an important application of arrays and linked lists. A polynomial is composed of different terms where each of them holds a coefficient and an exponent. A polynomial  $p(x)$  is the expression in variable  $x$  which is in the form  $(a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0)$ , where  $a_n, a_{n-1}, \dots, a_0$  fall in the category of real numbers and 'n' is the non-negative integer, which is called the degree of polynomial.

**Example:**  $10x^2 + 26x$ , here 10 and 26 are coefficients and 2, 1 is its exponential value.

**Points to keep in Mind while working with Polynomials:**

- The sign of each coefficient and exponent is stored within the coefficient and the exponent itself.
- The storage allocation for each term in the polynomial must be done in descending order of their exponent.

**In this question, complete SLinkedList class is included. You should use this class to complete your Polynomial class with initialized frame as following. This task is implement insertTerm to insert a term into a polynomial.**

```
class Polynomial;
class Term {
private:
    double coeff;
    int exp;
    friend class Polynomial;
public:
    Term(double coeff = 0.0, int exp = 0) {
        this->coeff = coeff;
        this->exp = exp;
    }
    bool operator==(const Term& rhs) const {
        return this->coeff == rhs.coeff && this->exp == rhs.exp;
    }
    friend ostream & operator<<(ostream &os, const Term& term) {
        cout << endl;
        cout << "Term: " << "(" << term.coeff << " " << term.exp << ")";
        return os;
    }
};

class Polynomial {
private:
    SLinkedList<Term>* terms;
public:
    Polynomial() {
        this->terms = new SLinkedList<Term>();
    }
    ~Polynomial() {
        this->terms->clear();
    }
    void insertTerm(const Term& term);
    void insertTerm(double coeff, int exp);
    void print() {
        SLinkedList<Term>::Iterator it;
        cout << "[";
        for (it = this->terms->begin(); it != this->terms->end(); it++) {
            cout << (*it);
        }
    }
};
```

```

        cout << endl << "];"
    }
};

```

**For example:**

Test	Result
<pre> Polynomial *poly = new Polynomial(); poly-&gt;insertTerm(6.0, 2); poly-&gt;insertTerm(4.0, 5); poly-&gt;insertTerm(4.0, 3); poly-&gt;insertTerm(6.0, 5); poly-&gt;insertTerm(-1.0, 0); poly-&gt;insertTerm(-6.0, 6); poly-&gt;insertTerm(6.0, 6); poly-&gt;print(); </pre>	<pre> [ Term: (10 5) Term: (4 3) Term: (6 2) Term: (-1 0) ] </pre>
<pre> int n = 5; int coeff[] = { 1, 2, 3, 4, 5 }; int exp[] = { 1, 2, 3, 4, 5 };  Polynomial p1; for (int i = 0; i &lt; n; ++i)     p1.insertTerm(coeff[i], exp[i]);  p1.print(); </pre>	<pre> [ Term: (5 5) Term: (4 4) Term: (3 3) Term: (2 2) Term: (1 1) ] </pre>

**Answer:** (penalty regime: 0, 0, 0, 5, 10 %)

Reset answer

```

1 void Polynomial::insertTerm(const Term &term)
2 {
3     bool check = false;
4     for (int i = 0; i < terms->size(); i++)
5     {
6         if (term.exp == (terms->get(i)).exp)
7         {

```

```
8      Term newterm(term.coeff + (terms->get(i)).coeff, term.exp);
9      if (newterm.coeff == 0)
10         terms->removeAt(i);
11     else
12         terms->set(i, newterm);
13     check = true;
14     break;
15 }
16 else if ((i < terms->size() - 1) &&
17         (term.exp < (terms->get(i)).exp) &&
18         (term.exp > (terms->get(i + 1)).exp))
19 {
20     terms->add(i + 1, term);
21     check = true;
22     break;
23 }
24 }
25 if (!check)
26 {
27     if ((terms->size() == 0) || (term.exp > (terms->get(0)).exp))
28         terms->add(0, term);
29     else
30         terms->add(term);
31 }
32 }
33
34 void Polynomial::insertTerm(double coeff, int exp)
35 {
36     if (coeff != 0)
37     {
38         Term term;
39         term.coeff = coeff;
40         term.exp = exp;
41         insertTerm(term);
42     }
43 }
```



	Test	Expected	Got	
✓	<pre>Polynomial *poly = new Polynomial(); poly-&gt;insertTerm(6.0, 2); poly-&gt;insertTerm(4.0, 5); poly-&gt;insertTerm(4.0, 3); poly-&gt;insertTerm(6.0, 5); poly-&gt;insertTerm(-1.0, 0); poly-&gt;insertTerm(-6.0, 6); poly-&gt;insertTerm(6.0, 6); poly-&gt;print();</pre>	<pre>[ Term: (10 5) Term: (4 3) Term: (6 2) Term: (-1 0) ]</pre>	<pre>[ Term: (10 5) Term: (4 3) Term: (6 2) Term: (-1 0) ]</pre>	✓
✓	<pre>int n = 5; int coeff[] = { 1, 2, 3, 4, 5 }; int exp[] = { 1, 2, 3, 4, 5 };  Polynomial p1; for (int i = 0; i &lt; n; ++i)     p1.insertTerm(coeff[i], exp[i]);  p1.print();</pre>	<pre>[ Term: (5 5) Term: (4 4) Term: (3 3) Term: (2 2) Term: (1 1) ]</pre>	<pre>[ Term: (5 5) Term: (4 4) Term: (3 3) Term: (2 2) Term: (1 1) ]</pre>	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 3

Chính xác

Điểm 0,90 của 1,00

Implement Iterator class in class SLinkedList.

**Note:** Iterator is a concept of repetitive elements on sequence structures. Iterator is implemented in class vector, list in STL container in C++ (<https://www.geeksforgeeks.org/iterators-c-stl/>). Your task is to implement the simple same class with iterator in C++ STL container.

**Please read example and testcase carefully.**

```
template <class T>
class SLinkedList
{
public:
    class Iterator; //forward declaration
    class Node;     //forward declaration
protected:
    Node *head;
    Node *tail;
    int count;
public:
    SLinkedList() : head(NULL), tail(NULL), count(0){};
    ~SLinkedList();
    void add(const T &e);
    void add(int index, const T &e);
    T removeAt(int index);
    bool removeItem(const T &removeItem);
    bool empty();
    int size();
    void clear();
    T get(int index);
    void set(int index, const T &e);
    int indexOf(const T &item);
    bool contains(const T &item);
    string toString();
    SLinkedList(const SLinkedList &list)
    {
        this->count = 0;
        this->head = NULL;
        this->tail = NULL;
    }
    Iterator begin()
    {
        return Iterator(this, true);
    }
    Iterator end()
    {
        return Iterator(this, false);
    }
};
```

```
    }  
public:  
    class Node  
    {  
    private:  
        T data;  
        Node *next;  
        friend class SLinkedList<T>;  
    public:  
        Node()  
        {  
            next = 0;  
        }  
        Node(Node *next)  
        {  
            this->next = next;  
        }  
        Node(T data, Node *next = NULL)  
        {  
            this->data = data;  
            this->next = next;  
        }  
    };  
    class Iterator  
    {  
    private:  
        SLinkedList<T> *pList;  
        Node *current;  
        int index; // corresponding with current node  
    public:  
        Iterator(SLinkedList<T> *pList, bool begin);  
        Iterator &operator=(const Iterator &iterator);  
        void set(const T &e);  
        T &operator*();  
        bool operator!=(const Iterator &iterator);  
  
        // Prefix ++ overload  
        Iterator &operator++();
```

```

        // Postfix ++ overload
        Iterator operator++(int);
    };
};

```

**For example:**

Test	Result
<pre> SLinkedList&lt;int&gt; list;  int size = 10; for(int idx=0; idx &lt; size; idx++){     list.add(idx); }  SLinkedList&lt;int&gt;::Iterator it; int expvalue = 0; for(it = list.begin(); it != list.end(); it++){     assert(*it == expvalue);     expvalue += 1; } </pre>	
<pre> SLinkedList&lt;int&gt; list;  int size = 10; for(int idx=0; idx &lt; size; idx++){     list.add(idx); }  SLinkedList&lt;int&gt;::Iterator it; int expvalue = 0; for(it = list.begin(); it != list.end(); ++it){     assert(*it == expvalue);     expvalue += 1; } </pre>	

**Answer:** (penalty regime: 0, 0, 0, 5, 10 %)

Reset answer

```
1 template <class T>
2 SLinkedList<T>::Iterator::Iterator(SLinkedList<T> *pList, bool begin)
3 {
4     this->pList = pList;
5     if (begin)
6     {
7         if (pList != nullptr && pList->head != nullptr)
8         {
9             index = 0;
10            current = pList->head;
11        }
12        else
13        {
14            index = -1;
15            current = nullptr;
16        }
17    }
18    else
19    {
20        current = nullptr;
21        if (pList != nullptr)
22            index = pList->count;
23        else
24            index = 0;
25    }
26 }
27
28 template <class T>
29 typename SLinkedList<T>::Iterator &SLinkedList<T>::Iterator::operator=(const Iterator &iterator)
30 {
31     current = iterator.current;
32     index = iterator.index;
33     pList = iterator.pList;
34     return *this;
35 }
36
37 template <class T>
38 void SLinkedList<T>::Iterator::remove()
```

```
39 {  
40     if (current == nullptr)  
41         throw std::out_of_range("Segmentation fault!");  
42     if (index == 0)  
43     {  
44         pList->removeAt(0);  
45         current = nullptr;  
46         index = -1;  
47     }  
48     else  
49     {  
50         int newIndex = index - 1;  
51         current->data = pList->get(newIndex);  
52         pList->removeAt(newIndex);  
53         index = newIndex;  
54     }  
55 }  
56  
57 template <class T>  
58 void SLinkedList<T>::Iterator::set(const T &e)  
59 {  
60     if (current == nullptr)  
61         throw std::out_of_range("Segmentation fault!");  
62     current->data = e;
```



	Test
✓	<pre> SLinkedList&lt;int&gt; list;  int size = 10; for(int idx=0; idx &lt; size; idx++){     list.add(idx); }  SLinkedList&lt;int&gt;::Iterator it; int expvalue = 0; for(it = list.begin(); it != list.end(); it++){     assert(*it == expvalue);     expvalue += 1; } </pre>
✓	<pre> SLinkedList&lt;int&gt; list;  int size = 10; for(int idx=0; idx &lt; size; idx++){     list.add(idx); }  SLinkedList&lt;int&gt;::Iterator it; int expvalue = 0; for(it = list.begin(); it != list.end(); ++it){     assert(*it == expvalue);     expvalue += 1; } </pre>

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00. Tính toán cho lần làm bài trước đó, điểm **0,90/1,00**.

## Câu hỏi 4

Chính xác

Điểm 1,00 của 1,00

**Class `LinkedList` is used to represent single linked list, described as the following:**

```
class LinkedList {
    public:
        class Node;
    private:
        Node* head;
        Node* tail;
        int size;
    public:
        class Node {
            private:
                int value;
                Node* next;
                friend class LinkedList;
            public:
                Node() {
                    this->next = NULL;
                }
                Node(Node* node) {
                    this->value = node->value;
                    this->next = node->next;
                }
                Node(int value, Node* next = NULL) {
                    this->value = value;
                    this->next = next;
                }
        }
}
```

```
};
LinkedList(): head(NULL), tail(NULL), size(0) {};
void partition(int k);
};
```

In this class; **head**, **tail** and **size** are the pointers of the first element, the last element and size of linked list.

**Request: Implement function**

```
void LinkedList::partition(int k);
```

To rearrange elements in this linked list by this way: split all elements of this linked list to 3 groups include: group I (the value of each element is smaller than k), group II (the value of each element is equal to k) and group III (the value of each element is larger than k); after that, move group I to the head of linked list, group II is after group I and group III is after group II. Note that the orders of the elements of each group are unchanged.

Example:

- The given linked list: 10->55->45->42->50
- k=45

In this case, group I includes elements with value 10 and 42, group II includes elements with 45 and group III includes elements with value 55 and 50. Rearrange by above way, this linked list will become 10->42->45->55->50 (the orders of the elements in each group is unchanged: 10 before 42 and 55 before 50).

*Note: In this exercise, libraries `iostream`, `sstream` and `using namespace std`; have been used. You can add other functions for your answer, but you are not allowed to add other libraries.*

**For example:**

Test	Result
<pre>LinkedList* l1 = new LinkedList(); l1-&gt;add(20); l1-&gt;add(30); l1-&gt;add(10); l1-&gt;add(60); l1-&gt;add(40); l1-&gt;add(45); l1-&gt;add(55); l1-&gt;partition(45); cout &lt;&lt; l1-&gt;toString() &lt;&lt; "\n";</pre>	[ 20, 30, 10, 40, 45, 60, 55 ]

**Answer:** (penalty regime: 0 %)

Reset answer

```
1 void LinkedList::partition(int k) {
2     if (head == NULL || head->next == NULL) {
3         // No need to partition if the list is empty or has only one element.
4         return;
5     }
6
7     Node* group1_head = NULL;
8     Node* group1_tail = NULL;
9     Node* group2_head = NULL;
10    Node* group2_tail = NULL;
11    Node* group3_head = NULL;
12    Node* group3_tail = NULL;
13    Node* current = head;
14
15    while (current != NULL) {
16        Node* next = current->next;
17
18        if (current->value < k) {
19            // Add to group I
20            if (group1_tail == NULL) {
21                group1_head = current;
22                group1_tail = current;
23                current->next = NULL;
24            } else {
25                group1_tail->next = current;
26                group1_tail = current;
27                current->next = NULL;
28            }
29        } else if (current->value == k) {
30            // Add to group II
31            if (group2_tail == NULL) {
32                group2_head = current;
33                group2_tail = current;
34                current->next = NULL;
35            } else {
36                group2_tail->next = current;
37                group2_tail = current;
38                current->next = NULL;
```

```

39     }
40 } else {
41     // Add to group III
42     if (group3_tail == NULL) {
43         group3_head = current;
44         group3_tail = current;
45         current->next = NULL;
46     } else {
47         group3_tail->next = current;
48         group3_tail = current;
49         current->next = NULL;
50     }
51 }
52
53     current = next;
54 }
55
56 // Concatenate the three groups
57 if (group1_head == NULL) {
58     // If group I is empty, the new head becomes group II (if not empty) or group III.
59     if (group2_head != NULL) {
60         head = group2_head;
61         group2_tail->next = group3_head;
62     } else {
63         head = group3_head;
64     }
65 } else {
66     head = group1_head;
67     group1_tail->next = group2_head;
68     if (group2_head != NULL) {
69         group2_tail->next = group3_head;
70     } else {
71         group1_tail->next = group3_head;
72     }
73 }
74
75 // Update the tail pointer if necessary

```

	Test	Expected	Got	
✓	<pre>LinkedList* l1 = new LinkedList(); l1-&gt;add(20); l1-&gt;add(30); l1-&gt;add(10); l1-&gt;add(60); l1-&gt;add(40); l1-&gt; &gt;add(45); l1-&gt;add(55); l1-&gt;partition(45); cout &lt;&lt; l1-&gt;toString() &lt;&lt; "\n";</pre>	[ 20, 30, 10, 40, 45, 60, 55]	[ 20, 30, 10, 40, 45, 60, 55]	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 5

Chính xác

Điểm 1,00 của 1,00

Implement methods **add**, **size** in template class **SLinkedList** (which implements **List ADT**) representing the singly linked list with type **T** with the initialized frame. The description of each method is given in the code.

```
template <class T>
class SLinkedList {
public:
    class Node; // Forward declaration
protected:
    Node* head;
    Node* tail;
    int count;
public:
    SLinkedList();
    ~SLinkedList();
    void    add(T e);
    void    add(int index, T e);
    int     size();
public:
    class Node {
    private:
        T data;
        Node* next;
        friend class SLinkedList<T>;
    public:
        Node() {
            next = 0;
        }
        Node(Node* next) {
            this->next = next;
        }
        Node(T data, Node* next) {
            this->data = data;
            this->next = next;
        }
    };
};
```

**For example:**



Test	Result
<pre>SLinkedList&lt;int&gt; list; int size = 10;  for(int index = 0; index &lt; size; index++){     list.add(index); }  cout &lt;&lt; list.toString();</pre>	[0,1,2,3,4,5,6,7,8,9]
<pre>SLinkedList&lt;int&gt; list; int size = 10;  for(int index = 0; index &lt; size; index++){     list.add(0, index); }  cout &lt;&lt; list.toString();</pre>	[9,8,7,6,5,4,3,2,1,0]

**Answer:** (penalty regime: 0, 0, 0, 5, 10, 15, ... %)

Reset answer

```

1 template <class T>
2 void SLinkedList<T>::add(const T& e) {
3     Node* newNode = new Node(e, nullptr);
4
5     if (head == nullptr) {
6         head = newNode;
7         tail = newNode;
8     } else {
9         tail->next = newNode;
10        tail = newNode;
11    }
12
13    count++;
14 }
15
```

```
16 template<class T>
17 void SLinkedList<T>::add(int index, const T& e) {
18     if (index < 0 || index > count) {
19         throw std::out_of_range("Index out of bounds");
20     }
21
22     if (index == count) {
23         add(e);
24         return;
25     }
26
27     Node* newNode = new Node(e, nullptr);
28
29     if (index == 0) {
30         newNode->next = head;
31         head = newNode;
32     } else {
33         Node* prevNode = head;
34         for (int i = 0; i < index - 1; i++) {
35             prevNode = prevNode->next;
36         }
37
38         newNode->next = prevNode->next;
39         prevNode->next = newNode;
40     }
41
42     count++;
43 }
44
45
46 template<class T>
47 int SLinkedList<T>::size() {
48     return count;
49 }
50
```

	Test	Expected	Got	
✓	<pre>SLinkedList&lt;int&gt; list; int size = 10;  for(int index = 0; index &lt; size; index++){     list.add(index); }  cout &lt;&lt; list.toString();</pre>	[0,1,2,3,4,5,6,7,8,9]	[0,1,2,3,4,5,6,7,8,9]	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 6

Chính xác

Điểm 1,00 của 1,00

Implement methods **get**, **set**, **empty**, **indexOf**, **contains** in template class **SLinkedList** (which implements **List ADT**) representing the singly linked list with type T with the initialized frame. The description of each method is given in the code.

```
template <class T>
class SLinkedList {
public:
    class Node; // Forward declaration
protected:
    Node* head;
    Node* tail;
    int count;
public:
    SLinkedList(): head(NULL), tail(NULL), count(0);
    ~SLinkedList() { };
    void    add(T e);
    void    add(int index, T e);
    int     size();
    bool    empty();
    T       get(int index);
    void    set(int index, T e);
    int     indexOf(T item);
    bool    contains(T item);
public:
    class Node {
    private:
        T data;
        Node* next;
        friend class SLinkedList<T>;
    public:
        Node() {
            next = 0;
        }
        Node(Node* next) {
            this->next = next;
        }
        Node(T data, Node* next = NULL) {
            this->data = data;
            this->next = next;
        }
    };
};
```

**For example:**

Test	Result
<pre> SLinkedList&lt;int&gt; list; int values[] = {10, 15, 2, 6, 4, 7, 40, 8}; int index[] = {0, 0, 1, 3, 2, 3, 5, 0}; int expvalues[] = {8, 15, 2, 4, 7, 10, 40, 6};  for (int idx = 0; idx &lt; 8; idx++){     list.add(index[idx], values[idx]); }  assert( list.size() == 8 );  for (int idx = 0; idx &lt; 8; idx++){     assert( list.get(idx) == expvalues[idx] ); }  cout &lt;&lt; list.toString(); </pre>	[8,15,2,4,7,10,40,6]
<pre> SLinkedList&lt;int&gt; list;  assert( list.empty() == true ); cout &lt;&lt; list.toString(); </pre>	[]

**Answer:** (penalty regime: 0, 0, 0, 5, 10, 15, ... %)

Reset answer

```

1 template <class T>
2 T SLinkedList<T>::get(int index)
3 {
4     if (index < 0 || index >= count)
5     {
6         throw std::out_of_range("Index out of range");
7     }

```

```

  9      Node *current = head;
10      for (int i = 0; i < index; i++)
11      {
12          current = current->next;
13      }
14
15      return current->data;
16  }
17
18  template <class T>
19  void SLinkedList<T>::set(int index, const T &e)
20  {
21      if (index < 0 || index >= count)
22      {
23          throw std::out_of_range("Index out of range");
24      }
25
26      Node *current = head;
27      for (int i = 0; i < index; i++)
28      {
29          current = current->next;
30      }
31
32      current->data = e;
33  }
34
35  template <class T>
36  bool SLinkedList<T>::empty()
37  {
38      return count == 0;
39  }
40
41  template <class T>
42  int SLinkedList<T>::indexOf(const T &item)
43  {
44      int index = 0;
45      Node *current = head;
46      while (current != nullptr)
47      {
48          if (current->data == item)
49          {
```

```

50         return index;
51     }
52     current = current->next;
53     index++;
54 }
55 return -1;
56 }
57
58 template <class T>
59 bool SLinkedList<T>::contains(const T &item)
60 {
61     return indexOf(item) != -1;
62 }

```

	Test	Expected	Got	
✓	<pre> SLinkedList&lt;int&gt; list; int values[] = {10, 15, 2, 6, 4, 7, 40, 8}; int index[] = {0, 0, 1, 3, 2, 3, 5, 0}; int expvalues[] = {8, 15, 2, 4, 7, 10, 40, 6};  for (int idx = 0; idx &lt; 8; idx++){     list.add(index[idx], values[idx]); }  assert( list.size() == 8 );  for (int idx = 0; idx &lt; 8; idx++){     assert( list.get(idx) == expvalues[idx] ); }  cout &lt;&lt; list.toString(); </pre>	[8,15,2,4,7,10,40,6]	[8,15,2,4,7,10,40,6]	✓



	Test	Expected	Got	
✓	<pre>SLinkedList&lt;int&gt; list;  assert( list.empty() == true ); cout &lt;&lt; list.toString();</pre>	[ ]	[ ]	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 7

Chính xác

Điểm 1,00 của 1,00

Implement methods **removeAt**, **removeItem**, **clear** in template class **SLinkedList** (which implements **List ADT**) representing the singly linked list with type T with the initialized frame. The description of each method is given in the code.

```
template <class T>
class SLinkedList {
public:
    class Node; // Forward declaration
protected:
    Node* head;
    Node* tail;
    int count;
public:
    SLinkedList();
    ~SLinkedList();
    void    add(T e);
    void    add(int index, T e);
    int     size();
    bool    empty();
    int     size();
    void    clear();
    T       get(int index);
    void    set(int index, T e);
    int     indexOf(T item);
    bool    contains(T item);
    T       removeAt(int index);
    bool    removeItem(T item);
public:
    class Node {
    private:
        T data;
        Node* next;
        friend class SLinkedList<T>;
    public:
        Node() {
            next = 0;
        }
        Node(Node* next) {
            this->next = next;
        }
        Node(T data, Node* next = NULL) {
            this->data = data;
```

```

        this->next = next;
    }
};
};

```

**For example:**

Test	Result
<pre> SLinkedList&lt;int&gt; list;  for (int i = 0; i &lt; 10; ++i) {     list.add(i); } assert(list.get(0) == list.removeAt(0));  cout &lt;&lt; list.toString(); </pre>	[1,2,3,4,5,6,7,8,9]
<pre> SLinkedList&lt;int&gt; list;  for (int i = 0; i &lt; 10; ++i) {     list.add(i); } assert(list.get(9) == list.removeAt(9));  cout &lt;&lt; list.toString(); </pre>	[0,1,2,3,4,5,6,7,8]
<pre> SLinkedList&lt;int&gt; list;  for (int i = 0; i &lt; 10; ++i) {     list.add(i); } assert(list.removeItem(9));  cout &lt;&lt; list.toString(); </pre>	[0,1,2,3,4,5,6,7,8]

**Answer:** (penalty regime: 0, 0, 0, 5, 10, 15, ... %)

Reset answer

```
1 template <class T>
2 T SLinkedList<T>::removeAt(int index)
3 {
4     if (index < 0 || index >= count)
5     {
6         throw std::out_of_range("Index out of range");
7     }
8
9     if (index == 0)
10    {
11        if (empty())
12        {
13            throw std::runtime_error("List is empty, cannot remove from the front");
14        }
15
16        Node *toRemove = head;
17        T removedValue = toRemove->data;
18        head = head->next;
19        delete toRemove;
20
21        if (head == nullptr)
22        {
23            tail = nullptr;
24        }
25
26        count--;
27
28        return removedValue;
29    }
30    else if (index == count - 1)
31    {
32        if (empty())
33        {
34            throw std::runtime_error("List is empty, cannot remove from the back");
35        }
36
37        if (count == 1)
38        {
```

```

39     T removedValue = head->data;
40     delete head;
41     head = nullptr;
42     tail = nullptr;
43     count--;
44     return removedValue;
45 }
46 else
47 {
48     Node *previous = head;
49     while (previous->next != tail)
50     {
51         previous = previous->next;
52     }
53
54     T removedValue = tail->data;
55     delete tail;
56     tail = previous;
57     tail->next = nullptr;
58     count--;
59
60     return removedValue;
61 }
62 }

```

	Test	Expected	Got	
✓	<pre> SLinkedList&lt;int&gt; list;  for (int i = 0; i &lt; 10; ++i) {     list.add(i); } assert(list.get(0) == list.removeAt(0));  cout &lt;&lt; list.toString(); </pre>	[1,2,3,4,5,6,7,8,9]	[1,2,3,4,5,6,7,8,9]	✓

	Test	Expected	Got	
✓	<pre>SLinkedList&lt;int&gt; list;  for (int i = 0; i &lt; 10; ++i) {     list.add(i); } assert(list.get(9) == list.removeAt(9));  cout &lt;&lt; list.toString();</pre>	[0,1,2,3,4,5,6,7,8]	[0,1,2,3,4,5,6,7,8]	✓

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 8

Chính xác

Điểm 1,00 của 1,00

Class `LLNode` representing a node of singly linked lists is declared as below:

```
class LLNode {
public:
    int val;
    LLNode* next;
    LLNode(); // Constructor: val = 0, next = nullptr
    LLNode(int val, LLNode* next); // Constructor with customized data
}
```

Given a singly linked list head node.

Your task is to implement a function with following prototype:

```
LLNode* reverseLinkedList(LLNode* head);
```

The function returns head node of the reversed singly linked list.

### Note:

- The `iostream` library has been included and `namespace std` is being used. No other libraries are allowed.
- The constructors and methods of class `LLNode` have been defined fully so you do not need to redefine them.
- You can write helper functions.

### For example:



Test	Result
<pre>int arr[] = {13, 88, 60, 7, 192}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[13, 88, 60, 7, 192] [192, 7, 60, 88, 13]</pre>

**Answer:** (penalty regime: 0 %)

Reset answer

```
1 LLNode *reverseLinkedList(LLNode *head)
2 {
3     // STUDENT ANSWER
4     LLNode *prev = nullptr;
5     LLNode *current = head;
6     LLNode *next = nullptr;
7
8     while (current != nullptr)
9     {
10         next = current->next;
11         current->next = prev;
12         prev = current;
13         current = next;
14     }
15
16     return prev;
17 }
```

	Test	Expected	Got	
✓	<pre>int arr[] = {13, 88, 60, 7, 192}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[13, 88, 60, 7, 192] [192, 7, 60, 88, 13]</pre>	<pre>[13, 88, 60, 7, 192] [192, 7, 60, 88, 13]</pre>	✓
✓	<pre>int arr[] = {}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[] []</pre>	<pre>[] []</pre>	✓
✓	<pre>int arr[] = {31, 22, 46, 152, 14, 87, 196, 97, 5, 93}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[31, 22, 46, 152, 14, 87, 196, 97, 5, 93] [93, 5, 97, 196, 87, 14, 152, 46, 22, 31]</pre>	<pre>[31, 22, 46, 152, 14, 87, 196, 97, 5, 93] [93, 5, 97, 196, 87, 14, 152, 46, 22, 31]</pre>	✓

	Test	Expected	Got	
✓	<pre>int arr[] = {115, 59, 178, 39, 109, 18, 154, 106, 94, 174, 51, 33, 132, 195, 161, 37, 61, 107, 120, 190}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[115, 59, 178, 39, 109, 18, 154, 106, 94, 174, 51, 33, 132, 195, 161, 37, 61, 107, 120, 190] [190, 120, 107, 61, 37, 161, 195, 132, 33, 51, 174, 94, 106, 154, 18, 109, 39, 178, 59, 115]</pre>	<pre>[115, 59, 178, 39, 109, 18, 154, 106, 94, 174, 51, 33, 132, 195, 161, 37, 61, 107, 120, 190] [190, 120, 107, 61, 37, 161, 195, 132, 33, 51, 174, 94, 106, 154, 18, 109, 39, 178, 59, 115]</pre>	✓

	Test	Expected	Got	
✓	<pre>int arr[] = {104, 50, 154, 40, 15, 171, 56, 114, 67, 90, 46, 179, 152, 177, 139, 45, 18, 55, 38, 158, 8, 157, 143, 37, 16, 83, 173, 82, 156, 51, 124, 25, 68, 51, 194, 105, 44, 17, 97, 0, 150, 66, 71, 81, 11, 180, 148, 160, 127, 93, 108, 13, 122, 172, 39, 88, 62, 38, 61, 156, 45, 131, 69, 191, 123, 42, 103, 56, 69, 138, 185, 162, 192, 147, 71, 80, 12, 36, 191, 121, 194, 86, 92, 183, 164, 97, 185, 130, 29, 174, 112, 194, 185, 132, 27, 197, 158, 151, 51, 174}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear();</pre>	<pre>[104, 50, 154, 40, 15, 171, 56, 114, 67, 90, 46, 179, 152, 177, 139, 45, 18, 55, 38, 158, 8, 157, 143, 37, 16, 83, 173, 82, 156, 51, 124, 25, 68, 51, 194, 105, 44, 17, 97, 0, 150, 66, 71, 81, 11, 180, 148, 160, 127, 93, 108, 13, 122, 172, 39, 88, 62, 38, 61, 156, 45, 131, 69, 191, 123, 42, 103, 56, 69, 138, 185, 162, 192, 147, 71, 80, 12, 36, 191, 121, 194, 86, 92, 183, 164, 97, 185, 130, 29, 174, 112, 194, 185, 132, 27, 197, 158, 151, 51, 174] [174, 51, 151, 158, 197, 27, 132, 185, 194, 112, 174, 29, 130, 185, 97, 164, 183, 92, 86, 194, 121, 191, 36, 12, 80, 71, 147, 192, 162, 185, 138, 69, 56, 103, 42, 123, 191, 69, 131, 45, 156, 61, 38, 62, 88, 39, 172, 122, 13, 108, 93, 127, 160, 148, 180, 11, 81, 71, 66, 150, 0, 97, 17, 44, 105, 194, 51, 68, 25, 124, 51, 156, 82, 173, 83, 16, 37, 143, 157, 8, 158, 38, 55, 18, 45, 139, 177, 152, 179, 46, 90, 67, 114, 56, 171, 15, 40, 154, 50, 104]</pre>	<pre>[104, 50, 154, 40, 15, 171, 56, 114, 67, 90, 46, 179, 152, 177, 139, 45, 18, 55, 38, 158, 8, 157, 143, 37, 16, 83, 173, 82, 156, 51, 124, 25, 68, 51, 194, 105, 44, 17, 97, 0, 150, 66, 71, 81, 11, 180, 148, 160, 127, 93, 108, 13, 122, 172, 39, 88, 62, 38, 61, 156, 45, 131, 69, 191, 123, 42, 103, 56, 69, 138, 185, 162, 192, 147, 71, 80, 12, 36, 191, 121, 194, 86, 92, 183, 164, 97, 185, 130, 29, 174, 112, 194, 185, 132, 27, 197, 158, 151, 51, 174] [174, 51, 151, 158, 197, 27, 132, 185, 194, 112, 174, 29, 130, 185, 97, 164, 183, 92, 86, 194, 121, 191, 36, 12, 80, 71, 147, 192, 162, 185, 138, 69, 56, 103, 42, 123, 191, 69, 131, 45, 156, 61, 38, 62, 88, 39, 172, 122, 13, 108, 93, 127, 160, 148, 180, 11, 81, 71, 66, 150, 0, 97, 17, 44, 105, 194, 51, 68, 25, 124, 51, 156, 82, 173, 83, 16, 37, 143, 157, 8, 158, 38, 55, 18, 45, 139, 177, 152, 179, 46, 90, 67, 114, 56, 171, 15, 40, 154, 50, 104]</pre>	✓

	Test	Expected	Got	
✓	<pre>int arr[] = {106, 14, 71, 71, 166, 172, 128, 128, 52, 113, 58, 184, 70, 73, 37, 83, 71, 46, 133, 100, 37, 186, 199, 69, 79, 71, 70, 13, 155, 90, 60, 82, 180, 125, 108, 160, 74, 93, 72, 152, 106, 11, 174, 164, 168, 6, 9, 41, 58, 65, 141, 22, 103, 49, 114, 197, 175, 131, 109, 135, 124, 19, 76, 109, 130, 15, 120, 12, 11, 77, 88, 56, 127, 162, 67, 133, 162, 22, 94, 122, 53, 132, 167, 111, 138, 61, 169, 64, 98, 159, 58, 147, 137, 50, 193, 190, 173, 28, 35, 108, 138, 110, 184, 82, 114, 199, 137, 156, 155, 167, 165, 134, 193, 22, 173, 176, 46, 61, 196, 137, 151, 69, 67, 87, 161, 72, 60, 70, 67, 109, 149, 16, 38, 127, 15, 12, 107, 48, 184, 185, 43, 178, 14, 188, 61, 79, 189, 144, 27, 41, 114, 182, 118, 76, 89, 126, 124, 195, 180, 133, 118, 96, 61, 95, 127, 40, 62, 102, 130, 174, 47, 131, 187, 103, 88, 109, 153, 110, 184, 72, 178, 41, 93, 112, 24, 156, 180, 150, 114, 172, 43, 170, 46, 166, 109, 193, 13, 17, 190, 153, 80, 106, 199, 163, 106, 39, 85, 56, 174, 189, 61, 72, 154, 149, 59, 110, 139, 189, 99, 40, 84, 180, 23, 13, 9, 192, 163, 88, 1, 3, 149, 132, 36, 34, 120, 40, 48, 32, 91, 166, 42, 155, 30, 111, 140, 6, 189, 169, 50, 15, 144, 67, 145, 169, 49, 135, 49, 76, 0, 105, 90, 60, 75, 88, 150, 88, 122, 11, 158, 12, 43, 182, 152, 112, 65, 149, 14, 194, 146, 120, 114, 178, 177, 159, 105, 45, 169, 152, 150, 60, 99, 39, 73, 101, 162, 173, 127, 122, 157, 116, 139, 57, 101, 121, 45, 133, 151, 171, 186, 186, 116, 4, 173, 118, 103, 70, 133, 158, 119, 47, 142, 111, 110, 96, 68, 118, 153, 178, 174, 130, 176, 186, 23, 193, 40, 175, 107, 184, 168, 185, 56, 167, 169, 68, 42, 75, 26, 174, 92, 46, 18, 85, 131, 164, 15, 116, 197, 88, 143, 8, 115, 199, 173, 142, 139, 162, 62, 7, 33, 2, 4, 54, 22, 135, 194, 34, 17, 90, 154, 71, 6, 156, 76, 66, 172, 157, 39, 92, 68, 169, 117, 166, 86, 153, 106, 63, 142, 190, 149,</pre>	<pre>[106, 14, 71, 71, 166, 172, 128, 128, 52, 113, 58, 184, 70, 73, 37, 83, 71, 46, 133, 100, 37, 186, 199, 69, 79, 71, 70, 13, 155, 90, 60, 82, 180, 125, 108, 160, 74, 93, 72, 152, 106, 11, 174, 164, 168, 6, 9, 41, 58, 65, 141, 22, 103, 49, 114, 197, 175, 131, 109, 135, 124, 19, 76, 109, 130, 15, 120, 12, 11, 77, 88, 56, 127, 162, 67, 133, 162, 22, 94, 122, 53, 132, 167, 111, 138, 61, 169, 64, 98, 159, 58, 147, 137, 50, 193, 190, 173, 28, 35, 108, 138, 110, 184, 82, 114, 199, 137, 156, 155, 167, 165, 134, 193, 22, 173, 176, 46, 61, 196, 137, 151, 69, 67, 87, 161, 72, 60, 70, 67, 109, 149, 16, 38, 127, 15, 12, 107, 48, 184, 185, 43, 178, 14, 188, 61, 79, 189, 144, 27, 41, 114, 182, 118, 76, 89, 126, 124, 195, 180, 133, 118, 96, 61, 95, 127, 40, 62, 102, 130, 174, 47, 131, 187, 103, 88, 109, 153, 110, 184, 72, 178, 41, 93, 112, 24, 156, 180, 150, 114, 172, 43, 170, 46, 166, 109, 193, 13, 17, 190, 153, 80, 106, 199, 163, 106, 39, 85, 56, 174, 189, 61, 72, 154, 149, 59, 110, 139, 189, 99, 40, 84, 180, 23, 13, 9, 192,</pre>	<pre>[106, 14, 71, 71, 166, 172, 128, 128, 52, 113, 58, 184, 70, 73, 37, 83, 71, 46, 133, 100, 37, 186, 199, 69, 79, 71, 70, 13, 155, 90, 60, 82, 180, 125, 108, 160, 74, 93, 72, 152, 106, 11, 174, 164, 168, 6, 9, 41, 58, 65, 141, 22, 103, 49, 114, 197, 175, 131, 109, 135, 124, 19, 76, 109, 130, 15, 120, 12, 11, 77, 88, 56, 127, 162, 67, 133, 162, 22, 94, 122, 53, 132, 167, 111, 138, 61, 169, 64, 98, 159, 58, 147, 137, 50, 193, 190, 173, 28, 35, 108, 138, 110, 184, 82, 114, 199, 137, 156, 155, 167, 165, 134, 193, 22, 173, 176, 46, 61, 196, 137, 151, 69, 67, 87, 161, 72, 60, 70, 67, 109, 149, 16, 38, 127, 15, 12, 107, 48, 184, 185, 43, 178, 14, 188, 61, 79, 189, 144, 27, 41, 114, 182, 118, 76, 89, 126, 124, 195, 180, 133, 118, 96, 61, 95, 127, 40, 62, 102, 130, 174, 47, 131, 187, 103, 88, 109, 153, 110, 184, 72, 178, 41, 93, 112, 24, 156, 180, 150, 114, 172, 43, 170, 46, 166, 109, 193, 13, 17, 190, 153, 80, 106, 199, 163, 106, 39, 85, 56, 174, 189, 61, 72, 154, 149, 59, 110, 139, 189, 99, 40, 84, 180, 23, 13, 9, 192,</pre>	✓

Test	Expected	Got
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<pre> 96, 27, 66, 69, 194, 37, 146, 107, 161, 11, 11, 150, 135, 145, 183, 135, 3, 106, 124, 34, 158, 149, 37, 134, 61, 112, 100, 54, 70, 81, 181, 141, 134, 130, 44, 30, 26, 29, 145, 2, 45, 9, 138, 158, 97, 43, 10, 195, 106, 32, 121, 111, 55, 98, 141, 93, 74, 33, 111, 105, 18, 124, 128, 86, 79, 41, 14, 75, 198, 33, 162, 171, 101, 111, 100, 132, 42, 98, 25, 98, 23, 169, 140, 109, 96, 111, 18, 81, 0, 104, 74, 37, 81, 90, 21, 166, 106, 191, 170, 44, 6, 90, 174, 44, 195, 88, 154, 64, 112, 33, 61, 141, 98, 14, 91, 59, 137, 150, 118, 114, 55, 36, 108, 83, 144}; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = reverseLinkedList(head); LLNode::printList(newhead); newhead-&gt;clear(); </pre>	<pre> 106, 12, 89, 90, 131, 104, 38, 11, 6, 148, 107, 135, 119, 81, 20, 71, 67, 67, 173, 54, 108, 99, 134, 183, 158, 175, 61, 97, 49, 167, 11, 87, 159, 49, 99, 18, 0, 128, 40, 160, 132, 97, 14, 65, 185, 120, 195, 160, 38, 170, 79, 88, 174, 114, 42, 169, 32, 136, 5, 186, 94, 31, 156, 95, 45, 199, 122, 93, 172, 12, 157, 180, 0, 93, 131, 165, 136, 16, 149, 86, 52, 20, 66, 122, 82, 160, 143, 29, 60, 179, 149, 87, 100, 68, 132, 32, 58, 52, 111, 92, 103, 138, 199, 39, 82, 134, 92, 171, 75, 16, 112, 32, 29, 171, 198, 60, 90, 53, 68, 36, 121, 112, 93, 51, 155, 7, 41, 97, 142, 122, 41, 14, 185, 91, 149, 144, 97, 5, 96, 74, 107, 98, 62, 150, 179, 53, 100, 61, 92, 8, 193, 165, 17, 96, 196, 180, 114, 110, 101, 67, 35, 64, 184, 148, 145, 119, 7, 176, 191, 75, 167, 59, 40, 109, 86, 105, 125, 20, 91, 46, 185, 11, 103, 137, 130, 169, 146, 170, 139, 2, 104, 157, 119, 85, 109, 142, 185, 71, 150, 158, 122, 190, 26, 133, 186, 89, 17, 33, 114, 135, 19, 23, 0, 173, 28, 176, 133, 125, 63, 174, 124, 12, 57, 24, 3, 11, 174, 99, 167, 193, 129, 51, 42, 184, 152, 193, 192, </pre>	<pre> 106, 12, 89, 90, 131, 104, 38, 11, 6, 148, 107, 135, 119, 81, 20, 71, 67, 67, 173, 54, 108, 99, 134, 183, 158, 175, 61, 97, 49, 167, 11, 87, 159, 49, 99, 18, 0, 128, 40, 160, 132, 97, 14, 65, 185, 120, 195, 160, 38, 170, 79, 88, 174, 114, 42, 169, 32, 136, 5, 186, 94, 31, 156, 95, 45, 199, 122, 93, 172, 12, 157, 180, 0, 93, 131, 165, 136, 16, 149, 86, 52, 20, 66, 122, 82, 160, 143, 29, 60, 179, 149, 87, 100, 68, 132, 32, 58, 52, 111, 92, 103, 138, 199, 39, 82, 134, 92, 171, 75, 16, 112, 32, 29, 171, 198, 60, 90, 53, 68, 36, 121, 112, 93, 51, 155, 7, 41, 97, 142, 122, 41, 14, 185, 91, 149, 144, 97, 5, 96, 74, 107, 98, 62, 150, 179, 53, 100, 61, 92, 8, 193, 165, 17, 96, 196, 180, 114, 110, 101, 67, 35, 64, 184, 148, 145, 119, 7, 176, 191, 75, 167, 59, 40, 109, 86, 105, 125, 20, 91, 46, 185, 11, 103, 137, 130, 169, 146, 170, 139, 2, 104, 157, 119, 85, 109, 142, 185, 71, 150, 158, 122, 190, 26, 133, 186, 89, 17, 33, 114, 135, 19, 23, 0, 173, 28, 176, 133, 125, 63, 174, 124, 12, 57, 24, 3, 11, 174, 99, 167, 193, 129, 51, 42, 184, 152, 193, 192, </pre>

Test	Expected	Got
	182, 166, 77, 147, 45, 61, 159, 75, 6, 83, 81, 186, 98, 92, 136, 38, 130, 40, 132, 111, 145, 174, 84, 100, 199, 176, 126, 185, 199, 57, 94, 12, 164, 189, 22, 8, 48, 120, 110, 48, 158, 17, 61, 64, 146, 72, 55, 81, 182, 149, 184, 91, 175, 122, 144, 23, 63, 4, 160, 174, 69, 78, 117, 28, 139, 118, 59, 169, 87, 60, 157, 64, 37, 32, 27, 169, 4, 139, 188, 92, 23, 192, 60, 39, 5, 68, 160, 82, 99, 132, 105, 80, 169, 46, 198, 169, 115, 2, 53, 157, 26, 9, 172, 99, 156, 71, 36, 83, 191, 21, 86, 17, 108, 18, 145, 42, 19, 51, 132, 155, 50, 192, 152, 0, 59, 89, 128, 27, 196, 160, 44, 149, 105, 24, 18, 137, 121, 22, 151, 111, 109, 111, 86, 30, 159, 59, 135, 6, 185, 40, 147, 27, 188, 33, 165, 14, 82, 95, 28, 97, 87, 65, 79, 146, 52, 152, 80, 130, 173, 54, 5, 77, 109, 128, 51, 148, 63, 185, 93, 153, 55, 33, 189, 50, 88, 174, 153, 58, 64, 49, 105, 117, 122, 91, 110, 130, 108, 74, 69, 197, 120, 110, 78, 124, 23, 153, 70, 91, 4, 150, 28, 163, 125, 89, 163, 16, 24, 15, 28, 115, 44, 94, 24, 85, 71, 0, 35, 5, 95, 125, 18, 99, 35, 47, 185, 118, 99, 161, 119,	182, 166, 77, 147, 45, 61, 159, 75, 6, 83, 81, 186, 98, 92, 136, 38, 130, 40, 132, 111, 145, 174, 84, 100, 199, 176, 126, 185, 199, 57, 94, 12, 164, 189, 22, 8, 48, 120, 110, 48, 158, 17, 61, 64, 146, 72, 55, 81, 182, 149, 184, 91, 175, 122, 144, 23, 63, 4, 160, 174, 69, 78, 117, 28, 139, 118, 59, 169, 87, 60, 157, 64, 37, 32, 27, 169, 4, 139, 188, 92, 23, 192, 60, 39, 5, 68, 160, 82, 99, 132, 105, 80, 169, 46, 198, 169, 115, 2, 53, 157, 26, 9, 172, 99, 156, 71, 36, 83, 191, 21, 86, 17, 108, 18, 145, 42, 19, 51, 132, 155, 50, 192, 152, 0, 59, 89, 128, 27, 196, 160, 44, 149, 105, 24, 18, 137, 121, 22, 151, 111, 109, 111, 86, 30, 159, 59, 135, 6, 185, 40, 147, 27, 188, 33, 165, 14, 82, 95, 28, 97, 87, 65, 79, 146, 52, 152, 80, 130, 173, 54, 5, 77, 109, 128, 51, 148, 63, 185, 93, 153, 55, 33, 189, 50, 88, 174, 153, 58, 64, 49, 105, 117, 122, 91, 110, 130, 108, 74, 69, 197, 120, 110, 78, 124, 23, 153, 70, 91, 4, 150, 28, 163, 125, 89, 163, 16, 24, 15, 28, 115, 44, 94, 24, 85, 71, 0, 35, 5, 95, 125, 18, 99, 35, 47, 185, 118, 99, 161, 119,

Test	Expected	Got
	10, 134, 17, 156, 134, 11, 61, 101, 117, 99, 4, 46, 163, 46, 71, 176, 10, 68, 160, 19, 165, 54, 177, 87, 28, 188, 167, 118, 73, 33, 88, 133, 99, 37, 163, 132, 17, 178, 63, 18, 48, 153, 198, 133, 160, 174, 115, 106, 68, 179, 17, 41, 184, 137, 22, 123, 152, 149, 48, 142, 62, 73, 102, 137, 52, 161, 171, 52, 147, 136, 6, 163, 10, 154, 196, 28, 19, 149, 186, 53, 170, 2, 165, 82, 64, 17, 53, 198, 135, 189, 49, 97, 5, 147, 60, 82, 198, 122, 41, 85, 117, 15, 26, 168, 172, 71, 15, 169, 172, 73, 44, 178, 134, 35, 108, 1, 51, 12, 21, 10, 48, 139, 139, 94, 14, 0, 153, 73, 73, 0, 149, 111, 103, 125, 92, 24, 3, 38, 110, 77, 75, 131, 106, 33, 110, 109, 92, 28, 49, 124, 38, 12, 132, 137, 197, 190, 17, 22, 62, 141, 13, 107, 48, 113, 169, 92, 163, 115, 50, 56, 185, 7, 63, 59, 187, 193, 155, 183, 111, 67, 84, 104, 81, 151, 131, 14, 15, 177, 197, 190, 65, 143, 25, 156, 137, 116, 98, 90, 127, 114, 88, 189, 88, 23, 65, 106, 95, 27, 93, 155, 4, 199, 99, 151, 53, 192, 125, 2, 98, 158, 155, 129, 100, 55, 119, 89, 128, 88, 60, 145, 169, 85, 132, 70, 76, 167, 25,	10, 134, 17, 156, 134, 11, 61, 101, 117, 99, 4, 46, 163, 46, 71, 176, 10, 68, 160, 19, 165, 54, 177, 87, 28, 188, 167, 118, 73, 33, 88, 133, 99, 37, 163, 132, 17, 178, 63, 18, 48, 153, 198, 133, 160, 174, 115, 106, 68, 179, 17, 41, 184, 137, 22, 123, 152, 149, 48, 142, 62, 73, 102, 137, 52, 161, 171, 52, 147, 136, 6, 163, 10, 154, 196, 28, 19, 149, 186, 53, 170, 2, 165, 82, 64, 17, 53, 198, 135, 189, 49, 97, 5, 147, 60, 82, 198, 122, 41, 85, 117, 15, 26, 168, 172, 71, 15, 169, 172, 73, 44, 178, 134, 35, 108, 1, 51, 12, 21, 10, 48, 139, 139, 94, 14, 0, 153, 73, 73, 0, 149, 111, 103, 125, 92, 24, 3, 38, 110, 77, 75, 131, 106, 33, 110, 109, 92, 28, 49, 124, 38, 12, 132, 137, 197, 190, 17, 22, 62, 141, 13, 107, 48, 113, 169, 92, 163, 115, 50, 56, 185, 7, 63, 59, 187, 193, 155, 183, 111, 67, 84, 104, 81, 151, 131, 14, 15, 177, 197, 190, 65, 143, 25, 156, 137, 116, 98, 90, 127, 114, 88, 189, 88, 23, 65, 106, 95, 27, 93, 155, 4, 199, 99, 151, 53, 192, 125, 2, 98, 158, 155, 129, 100, 55, 119, 89, 128, 88, 60, 145, 169, 85, 132, 70, 76, 167, 25,



Test	Expected	Got
	70, 199, 190, 52, 184, 188, 144, 53, 147, 50, 162, 130, 197, 125, 173, 147, 45, 71, 180, 173, 83, 174, 68, 77, 96, 199, 115, 167, 193, 156, 148, 175, 33, 98, 99, 96, 62, 54, 125, 131, 155, 64, 179, 66, 63, 192, 7, 149, 60, 136, 78, 172, 115, 10, 168, 158, 63, 28, 117, 81, 24, 40, 89, 67, 57, 184, 89, 160, 13, 10, 15, 37, 23, 152, 147, 188, 96, 99, 116, 88, 13, 121, 167, 67, 24, 180, 45, 199, 86, 85, 58, 98, 121, 25, 148, 172, 24, 146, 193, 149, 61, 72, 117, 59, 79, 162, 100, 89, 88, 167, 99, 14, 55, 178, 20, 116, 49, 173, 27, 183, 117, 4, 99, 145, 46, 46, 61, 116, 125, 31, 195, 103, 30, 137, 184, 36, 67, 68]	70, 199, 190, 52, 184, 188, 144, 53, 147, 50, 162, 130, 197, 125, 173, 147, 45, 71, 180, 173, 83, 174, 68, 77, 96, 199, 115, 167, 193, 156, 148, 175, 33, 98, 99, 96, 62, 54, 125, 131, 155, 64, 179, 66, 63, 192, 7, 149, 60, 136, 78, 172, 115, 10, 168, 158, 63, 28, 117, 81, 24, 40, 89, 67, 57, 184, 89, 160, 13, 10, 15, 37, 23, 152, 147, 188, 96, 99, 116, 88, 13, 121, 167, 67, 24, 180, 45, 199, 86, 85, 58, 98, 121, 25, 148, 172, 24, 146, 193, 149, 61, 72, 117, 59, 79, 162, 100, 89, 88, 167, 99, 14, 55, 178, 20, 116, 49, 173, 27, 183, 117, 4, 99, 145, 46, 46, 61, 116, 125, 31, 195, 103, 30, 137, 184, 36, 67, 68]

Passed all tests! ✓

Chính xác

Điểm cho bài nộp này: 1,00/1,00.

## Câu hỏi 9

Chính xác

Điểm 1,00 của 1,00

Class `LLNode` representing a node of singly linked lists is declared as below:

```
class LLNode {  
public:  
    int val;  
    LLNode* next;  
    LLNode(); // Constructor: val = 0, next = nullptr  
    LLNode(int val, LLNode* next); // Constructor with customized data  
}
```

Given a singly linked list head node and a integer `k`.

Your task is to implement a function with following prototype:

```
LLNode* rotateLinkedList(LLNode* head, int k);
```

The function returns head node of the rotated singly linked list obtained after rotate the linked list to the right by `k` places.

### Note:

- The `iostream` library has been used and `namespace std` is being used. No other libraries are allowed.
- The constructors and methods of class `LLNode` have been defined fully so you do not need to redefine them.
- You can write helper functions.

### For example:

Test	Result
<pre> int arr[] = {2, 4, 6, 6, 3}; int k = 3; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead); </pre>	<pre> [2, 4, 6, 6, 3] [6, 6, 3, 2, 4] </pre>

**Answer:** (penalty regime: 0 %)

Reset answer

```

1 LLNode *rotateLinkedList(LLNode *head, int k)
2 {
3     // STUDENT ANSWER
4     if (!head || k <= 0)
5     {
6         return head;
7     }
8
9     int length = 1;
10    LLNode *current = head;
11    while (current->next)
12    {
13        current = current->next;
14        length++;
15    }
16
17    k = k % length;
18
19    if (k == 0)
20    {
21        return head;
22    }

```

	Test	Expected	Got	
✓	<pre>int arr[] = {2, 4, 6, 6, 3}; int k = 3; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead);</pre>	<pre>[2, 4, 6, 6, 3] [6, 6, 3, 2, 4]</pre>	<pre>[2, 4, 6, 6, 3] [6, 6, 3, 2, 4]</pre>	✓
✓	<pre>int arr[] = {}; int k = 2; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead);</pre>	<pre>[] []</pre>	<pre>[] []</pre>	✓
✓	<pre>int arr[] = {0, 4, 2, 5, 1, 0, 6, 4, 8, 6}; int k = 11; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead);</pre>	<pre>[0, 4, 2, 5, 1, 0, 6, 4, 8, 6] [6, 0, 4, 2, 5, 1, 0, 6, 4, 8]</pre>	<pre>[0, 4, 2, 5, 1, 0, 6, 4, 8, 6] [6, 0, 4, 2, 5, 1, 0, 6, 4, 8]</pre>	✓

	Test	Expected	Got	
✓	<pre>int arr[] = {6, 1, 3, 2, 6, 0, 0, 0, 3, 3, 9, 8, 5, 6, 0, 7, 7, 8, 5, 7, 7, 9, 6, 3, 3, 0, 0, 8, 0, 0, 4, 9, 7, 1, 7, 2, 7, 5, 4, 4, 7, 5, 9, 2, 4, 5, 7, 9, 7, 9, 7, 2, 0, 6, 7, 6, 5, 1, 9, 7, 1, 2, 7, 8, 7, 5, 4, 7, 6, 9, 0, 2, 7, 0, 5, 5, 6, 8, 3, 1, 9, 3, 0, 1, 4, 6, 6, 9, 2, 2, 0, 6, 7, 4, 4, 6, 0, 7, 3, 5, 2, 9, 1, 0, 9}; int k = 35; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n"; LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead);</pre>	<pre>[6, 1, 3, 2, 6, 0, 0, 0, 3, 3, 9, 8, 5, 6, 0, 7, 7, 8, 5, 7, 7, 9, 6, 3, 3, 0, 0, 8, 0, 0, 4, 9, 7, 1, 7, 2, 7, 5, 4, 4, 7, 5, 9, 2, 4, 5, 7, 9, 7, 9, 7, 2, 0, 6, 7, 6, 5, 1, 9, 7, 1, 2, 7, 8, 7, 5, 4, 7, 6, 9, 0, 2, 7, 0, 5, 5, 6, 8, 3, 1, 9, 3, 0, 1, 4, 6, 6, 9, 2, 2, 0, 6, 7, 4, 4, 6, 0, 7, 3, 5, 2, 9, 1, 0, 9] [0, 2, 7, 0, 5, 5, 6, 8, 3, 1, 9, 3, 0, 1, 4, 6, 6, 9, 2, 2, 0, 6, 7, 4, 4, 6, 0, 7, 3, 5, 2, 9, 1, 0, 9, 6, 1, 3, 2, 6, 0, 0, 0, 3, 3, 9, 8, 5, 6, 0, 7, 7, 8, 5, 7, 7, 9, 6, 3, 3, 0, 0, 8, 0, 0, 4, 9, 7, 1, 7, 2, 7, 5, 4, 4, 7, 5, 9, 2, 4, 5, 7, 9, 7, 9, 7, 2, 0, 6, 7, 6, 5, 1, 9, 7, 1, 2, 7, 8, 7, 5, 4, 7, 6, 9]</pre>	<pre>[6, 1, 3, 2, 6, 0, 0, 0, 3, 3, 9, 8, 5, 6, 0, 7, 7, 8, 5, 7, 7, 9, 6, 3, 3, 0, 0, 8, 0, 0, 4, 9, 7, 1, 7, 2, 7, 5, 4, 4, 7, 5, 9, 2, 4, 5, 7, 9, 7, 9, 7, 2, 0, 6, 7, 6, 5, 1, 9, 7, 1, 2, 7, 8, 7, 5, 4, 7, 6, 9, 0, 2, 7, 0, 5, 5, 6, 8, 3, 1, 9, 3, 0, 1, 4, 6, 6, 9, 2, 2, 0, 6, 7, 4, 4, 6, 0, 7, 3, 5, 2, 9, 1, 0, 9] [0, 2, 7, 0, 5, 5, 6, 8, 3, 1, 9, 3, 0, 1, 4, 6, 6, 9, 2, 2, 0, 6, 7, 4, 4, 6, 0, 7, 3, 5, 2, 9, 1, 0, 9, 6, 1, 3, 2, 6, 0, 0, 0, 3, 3, 9, 8, 5, 6, 0, 7, 7, 8, 5, 7, 7, 9, 6, 3, 3, 0, 0, 8, 0, 0, 4, 9, 7, 1, 7, 2, 7, 5, 4, 4, 7, 5, 9, 2, 4, 5, 7, 9, 7, 9, 7, 2, 0, 6, 7, 6, 5, 1, 9, 7, 1, 2, 7, 8, 7, 5, 4, 7, 6, 9]</pre>	✓

	Test	Expected	Got	
✓	<pre>int arr[] = {9, 1, 7, 5, 8, 6, 2, 2, 2, 6, 0, 8, 1, 9, 6, 8, 4, 8, 4, 3, 7, 0, 7, 8, 9, 5, 3, 4, 7, 4, 3, 5, 2, 2, 7, 8, 9, 7, 1, 9, 9, 8, 3, 5, 7, 1, 6, 9, 1, 2, 0, 6, 8, 0, 4, 1, 6, 5, 8, 7, 6, 8, 0, 5, 7, 8, 8, 6, 7, 5, 8, 0, 7, 6, 4, 9, 5, 9, 6, 4, 1, 5, 6, 2, 2, 6, 7, 0, 3, 4, 2, 3, 9, 0, 9, 6, 3, 6, 7, 5, 5, 5, 9, 0, 6, 1, 1, 5, 0, 9, 1, 1, 1, 0, 4, 6, 3, 3, 3, 5, 8, 7, 4, 7, 1, 7, 1, 8, 4, 2, 0, 1, 9, 0, 7, 9, 2, 8, 9, 2, 5, 3, 5, 9, 3, 2, 7, 3, 5, 9, 5, 5, 3, 2, 3, 9, 4, 1, 6, 1, 8, 3, 1, 4, 5, 2, 5, 7, 7, 0, 9, 6, 6, 4, 8, 1, 1, 6, 0, 2, 6, 0, 7, 5, 5, 0, 5, 2, 6, 9, 9, 9, 9, 2, 3, 0, 6, 8, 8, 4, 5, 6, 2, 8, 5, 9, 8, 3, 6, 8, 8, 6, 2, 1, 2, 1, 4, 6, 2, 0, 9, 3, 9, 6, 4, 2, 3, 6, 2, 0, 9, 8, 7, 0, 6, 0, 7, 0, 5, 9, 4, 3, 7, 9, 7, 3, 5, 7, 0, 3, 1, 8, 9, 9, 4, 0, 8, 6, 4, 6, 7, 3, 8, 1, 2, 1, 5, 4, 9, 5, 9, 5, 8, 6, 6, 8, 9, 4, 4, 0, 6, 4, 5, 3, 0, 3, 9, 7, 1, 7, 2, 5, 0, 1, 9, 1, 2, 5, 6, 8, 7, 1, 6, 9, 6, 2, 8, 1, 2, 0, 4, 3, 4, 6, 7, 1, 0, 7, 0, 7, 9, 4, 0, 1, 2, 3, 5, 6, 3, 5, 6, 7, 5, 4, 2, 4, 8, 2, 5, 8, 8, 6, 6, 2, 6, 6, 8, 1, 2, 2, 8, 0, 8, 9, 0, 7, 9, 0, 1, 6, 6, 3, 6, 5, 1, 5, 9, 0, 3, 7, 3, 7, 2, 0, 0, 2, 7, 5, 2, 9, 5, 5, 8, 1, 7, 7, 9, 7, 1, 1, 6, 4, 3, 8, 0, 7, 9, 1, 0, 9, 5, 2, 7, 2, 1, 5, 3, 9, 7, 6, 9, 1, 3, 5, 5, 0, 6, 9, 4, 7, 1, 7, 2, 0, 4, 5, 8, 1, 6, 1, 0, 7, 2, 2, 6, 7, 4, 4, 9, 5, 4, 5, 2, 0, 8, 0, 5, 5, 1, 8, 9, 4, 5, 6, 1, 2, 0, 7, 0, 2, 1, 6, 8, 8, 7, 8, 7, 0, 1, 8, 5, 6, 5, 9, 2, 2, 9, 3, 6, 0, 1, 7, 9, 8, 1, 1, 5, 4, 5, 7, 5, 0, 2, 0, 4, 4, 8, 0, 7, 3};  int k = 196; LLNode* head = LLNode::createWithIterators(arr, arr + sizeof(arr) / sizeof(int)); LLNode::printList(head); cout &lt;&lt; "\n";</pre>	<pre>[9, 1, 7, 5, 8, 6, 2, 2, 2, 6, 0, 8, 1, 9, 6, 8, 4, 8, 4, 3, 7, 0, 7, 8, 9, 5, 3, 4, 7, 4, 3, 5, 2, 2, 7, 8, 9, 7, 1, 9, 9, 8, 3, 5, 7, 1, 6, 9, 1, 2, 0, 6, 8, 0, 4, 1, 6, 5, 8, 7, 6, 8, 0, 5, 7, 8, 8, 6, 7, 5, 8, 0, 7, 6, 4, 9, 5, 9, 6, 4, 1, 5, 6, 2, 2, 6, 7, 0, 3, 4, 2, 3, 9, 0, 9, 6, 3, 6, 7, 5, 5, 5, 9, 0, 6, 1, 1, 5, 0, 9, 1, 1, 1, 0, 4, 6, 3, 3, 3, 5, 8, 7, 4, 7, 1, 7, 1, 8, 4, 2, 0, 1, 9, 0, 7, 9, 2, 8, 9, 2, 5, 3, 5, 9, 3, 2, 7, 3, 5, 9, 5, 5, 3, 2, 3, 9, 4, 1, 6, 1, 8, 3, 1, 4, 5, 2, 5, 7, 7, 0, 9, 6, 6, 4, 8, 1, 1, 6, 0, 2, 6, 0, 7, 5, 5, 0, 5, 2, 6, 9, 9, 9, 9, 2, 3, 0, 6, 8, 8, 4, 5, 6, 2, 8, 5, 9, 8, 3, 6, 8, 8, 6, 2, 1, 2, 1, 4, 6, 2, 0, 9, 3, 9, 6, 4, 2, 3, 6, 2, 0, 9, 8, 7, 0, 6, 0, 7, 0, 5, 9, 4, 3, 7, 9, 7, 3, 5, 7, 0, 3, 1, 8, 9, 9, 4, 0, 8, 6, 4, 6, 7, 3, 8, 1, 2, 1, 5, 4, 9, 5, 9, 5, 8, 6, 6, 8, 9, 4, 4, 0, 6, 4, 5, 3, 0, 3, 9, 7, 1, 7, 2, 5, 0, 1, 9, 1, 2, 5, 6, 8, 7, 1, 6, 9, 6, 2, 8, 1, 2, 0, 4, 3, 4, 6, 7, 1, 0, 7, 0, 7, 9, 4, 0, 1, 2, 3, 5, 6, 3, 5, 6, 7, 5, 4, 2, 4, 8, 2, 5, 8, 8, 6, 6, 2, 6, 6, 8, 1, 2, 2, 8, 0, 8, 9, 0, 7, 9, 0, 1, 6,</pre>	<pre>[9, 1, 7, 5, 8, 6, 2, 2, 2, 6, 0, 8, 1, 9, 6, 8, 4, 8, 4, 3, 7, 0, 7, 8, 9, 5, 3, 4, 7, 4, 3, 5, 2, 2, 7, 8, 9, 7, 1, 9, 9, 8, 3, 5, 7, 1, 6, 9, 1, 2, 0, 6, 8, 0, 4, 1, 6, 5, 8, 7, 6, 8, 0, 5, 7, 8, 8, 6, 7, 5, 8, 0, 7, 6, 4, 9, 5, 9, 6, 4, 1, 5, 6, 2, 2, 6, 7, 0, 3, 4, 2, 3, 9, 0, 9, 6, 3, 6, 7, 5, 5, 5, 9, 0, 6, 1, 1, 5, 0, 9, 1, 1, 1, 0, 4, 6, 3, 3, 3, 5, 8, 7, 4, 7, 1, 7, 1, 8, 4, 2, 0, 1, 9, 0, 7, 9, 2, 8, 9, 2, 5, 3, 5, 9, 3, 2, 7, 3, 5, 9, 5, 5, 3, 2, 3, 9, 4, 1, 6, 1, 8, 3, 1, 4, 5, 2, 5, 7, 7, 0, 9, 6, 6, 4, 8, 1, 1, 6, 0, 2, 6, 0, 7, 5, 5, 0, 5, 2, 6, 9, 9, 9, 9, 2, 3, 0, 6, 8, 8, 4, 5, 6, 2, 8, 5, 9, 8, 3, 6, 8, 8, 6, 2, 1, 2, 1, 4, 6, 2, 0, 9, 3, 9, 6, 4, 2, 3, 6, 2, 0, 9, 8, 7, 0, 6, 0, 7, 0, 5, 9, 4, 3, 7, 9, 7, 3, 5, 7, 0, 3, 1, 8, 9, 9, 4, 0, 8, 6, 4, 6, 7, 3, 8, 1, 2, 1, 5, 4, 9, 5, 9, 5, 8, 6, 6, 8, 9, 4, 4, 0, 6, 4, 5, 3, 0, 3, 9, 7, 1, 7, 2, 5, 0, 1, 9, 1, 2, 5, 6, 8, 7, 1, 6, 9, 6, 2, 8, 1, 2, 0, 4, 3, 4, 6, 7, 1, 0, 7, 0, 7, 9, 4, 0, 1, 2, 3, 5, 6, 3, 5, 6, 7, 5, 4, 2, 4, 8, 2, 5, 8, 8, 6, 6, 2, 6, 6, 8, 1, 2, 2, 8, 0, 8, 9, 0, 7, 9, 0, 1, 6,</pre>	✓

Test	Expected	Got
<pre>LLNode* newhead = rotateLinkedList(head, k); LLNode::printList(newhead);</pre>	<pre>6, 3, 6, 5, 1, 5, 9, 0, 3, 7, 3, 7, 2, 0, 0, 2, 7, 5, 2, 9, 5, 5, 8, 1, 7, 7, 9, 7, 1, 1, 6, 4, 3, 8, 0, 7, 9, 1, 0, 9, 5, 2, 7, 2, 1, 5, 3, 9, 7, 6, 9, 1, 3, 5, 5, 0, 6, 9, 4, 7, 1, 7, 2, 0, 4, 5, 8, 1, 6, 1, 0, 7, 2, 2, 6, 7, 4, 4, 9, 5, 4, 5, 2, 0, 8, 0, 5, 5, 1, 8, 9, 4, 5, 6, 1, 2, 0, 7, 0, 2, 1, 6, 8, 8, 7, 8, 7, 0, 1, 8, 5, 6, 5, 9, 2, 2, 9, 3, 6, 0, 1, 7, 9, 8, 1, 1, 5, 4, 5, 7, 5, 0, 2, 0, 4, 4, 8, 0, 7, 3] [6, 2, 8, 1, 2, 0, 4, 3, 4, 6, 7, 1, 0, 7, 0, 7, 9, 4, 0, 1, 2, 3, 5, 6, 3, 5, 6, 7, 5, 4, 2, 4, 8, 2, 5, 8, 8, 6, 6, 2, 6, 6, 8, 1, 2, 2, 8, 0, 8, 9, 0, 7, 9, 0, 1, 6, 6, 3, 6, 5, 1, 5, 9, 0, 3, 7, 3, 7, 2, 0, 0, 2, 7, 5, 2, 9, 5, 5, 8, 1, 7, 7, 9, 7, 1, 1, 6, 4, 3, 8, 0, 7, 9, 1, 0, 9, 5, 2, 7, 2, 1, 5, 3, 9, 7, 6, 9, 1, 3, 5, 5, 0, 6, 9, 4, 7, 1, 7, 2, 0, 4, 5, 8, 1, 6, 1, 0, 7, 2, 2, 6, 7, 4, 4, 9, 5, 4, 5, 2, 0, 8, 0, 5, 5, 1, 8, 9, 4, 5, 6, 1, 2, 0, 7, 0, 2, 1, 6, 8, 8, 7, 8, 7, 0, 1, 8, 5, 6, 5, 9, 2, 2, 9, 3, 6, 0, 1, 7, 9, 8, 1, 1, 5, 4, 5, 7, 5, 0, 2, 0, 4, 4, 8, 0, 7, 3, 9, 1, 7, 5, 8, 6, 2, 2, 2, 6, 0, 8, 1, 9, 6, 8, 4, 8, 4, 3, 7, 0, 7, 8,</pre>	<pre>6, 3, 6, 5, 1, 5, 9, 0, 3, 7, 3, 7, 2, 0, 0, 2, 7, 5, 2, 9, 5, 5, 8, 1, 7, 7, 9, 7, 1, 1, 6, 4, 3, 8, 0, 7, 9, 1, 0, 9, 5, 2, 7, 2, 1, 5, 3, 9, 7, 6, 9, 1, 3, 5, 5, 0, 6, 9, 4, 7, 1, 7, 2, 0, 4, 5, 8, 1, 6, 1, 0, 7, 2, 2, 6, 7, 4, 4, 9, 5, 4, 5, 2, 0, 8, 0, 5, 5, 1, 8, 9, 4, 5, 6, 1, 2, 0, 7, 0, 2, 1, 6, 8, 8, 7, 8, 7, 0, 1, 8, 5, 6, 5, 9, 2, 2, 9, 3, 6, 0, 1, 7, 9, 8, 1, 1, 5, 4, 5, 7, 5, 0, 2, 0, 4, 4, 8, 0, 7, 3] [6, 2, 8, 1, 2, 0, 4, 3, 4, 6, 7, 1, 0, 7, 0, 7, 9, 4, 0, 1, 2, 3, 5, 6, 3, 5, 6, 7, 5, 4, 2, 4, 8, 2, 5, 8, 8, 6, 6, 2, 6, 6, 8, 1, 2, 2, 8, 0, 8, 9, 0, 7, 9, 0, 1, 6, 6, 3, 6, 5, 1, 5, 9, 0, 3, 7, 3, 7, 2, 0, 0, 2, 7, 5, 2, 9, 5, 5, 8, 1, 7, 7, 9, 7, 1, 1, 6, 4, 3, 8, 0, 7, 9, 1, 0, 9, 5, 2, 7, 2, 1, 5, 3, 9, 7, 6, 9, 1, 3, 5, 5, 0, 6, 9, 4, 7, 1, 7, 2, 0, 4, 5, 8, 1, 6, 1, 0, 7, 2, 2, 6, 7, 4, 4, 9, 5, 4, 5, 2, 0, 8, 0, 5, 5, 1, 8, 9, 4, 5, 6, 1, 2, 0, 7, 0, 2, 1, 6, 8, 8, 7, 8, 7, 0, 1, 8, 5, 6, 5, 9, 2, 2, 9, 3, 6, 0, 1, 7, 9, 8, 1, 1, 5, 4, 5, 7, 5, 0, 2, 0, 4, 4, 8, 0, 7, 3, 9, 1, 7, 5, 8, 6, 2, 2, 2, 6, 0, 8, 1, 9, 6, 8, 4, 8, 4, 3, 7, 0, 7, 8,</pre>

	Test	Expected	Got	
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