Version 1

Instructions

- **Write your name and version number on the top of the yellow paper.**
- **Answer all questions on the yellow paper.**
- **One question per page.**
- **Use only one side of the yellow paper.**

1. (16 Points) Multiple Choice:

A. (2 Points) Which of the following loop headers will arrange for the loop body to execute exactly 10 times?

```
a. for (int i = 1  ; i < 10  ; ++i)
b. for (int i = 0  ; i <= 10 ; ++i)
c. for (int i = –5 ; i < 5   ; ++i)
d. for (int i = 2  ; i < 20  ; ++i)
```

B. (2 Points) An instance of a class is known as a(n) _____.

```
a. module
b. object
c. abstract data type
d. data structure
```

C. (2 Points) A class method is defined as _____.

```
a. static
b. abstract
c. private
d. protected
```

D. (2 Points) The insertion operation of the ADT list can insert new items _____.

```
a. only at the front of the list
b. only at the end of the list
c. only in the middle of the list
d. into any position of the list
```

E. (2 Points) Which of the following will be true when the reference variable curr references the last node in a linear linked list?

```
a. curr == null
b. head == null
c. curr.getNext() == null
d. head.getNext() == null
```

F. (2 Points) In a grammar, the symbol x | y means _____.

```
a. x or y
b. x followed by y
c. x out of y
d. x divided by y
```

G. (2 Points) If the array: {6, 2, 7, 13, 5, 4}is added to a stack, in the order given, which number will be the first number to be removed from the stack?

```
a. 6
b. 2
c. 5
d. 4
```

H. 2 Points) Which of the following is the code to insert a new node, referenced by `newNode`, into an empty queue represented by a circular linked list?

```
a. newNode.setNext(lastNode);
b. lastNode.setNext(lastNode);
   lastNode = newNode;
c. newNode.setNext(lastNode);
   newNode = lastNode;
d. newNode.setNext(newNode);
   lastNode = newNode;
```

Version 1

2. (20 Points) Given the following StackInterface:

```
public interface StackInterface {
   public void push(Object obj);
   public Object pop();
   public Object peek();
}
```

And given the following array-based Stack that implements StackInterface:

```
import java.util.Vector;

public ArrayStack {

   private Vector<Object> stackVector = new Vector<>();

   private final int INVALID_STACK_POINTER = -1;
   private int stackPointer == INVALID_STACK_POINTER;

   @Override
   public void push(Object obj) {
      stackVector.add(stackPointer++, obj);
   }

   @Override
   public void pop() {
      Object obj = null;
      if (stackPointer != INVALID_STACK_POINTER) {
         obj = stackVector.elementAt(stackPointer);
         stackVector.removeElementAt(--stackPointer);
      }
   }

   @Override
   public Object peek() {
      Object obj = null;
      if (stackPointer == INVALID_STACK_POINTER) {
         obj = stackVector.elementAt(stackPointer);
      }
      return null;
   }
}
```

Re-write the ArrayStack class and fix the 10 syntax and logical errors.

Version 1

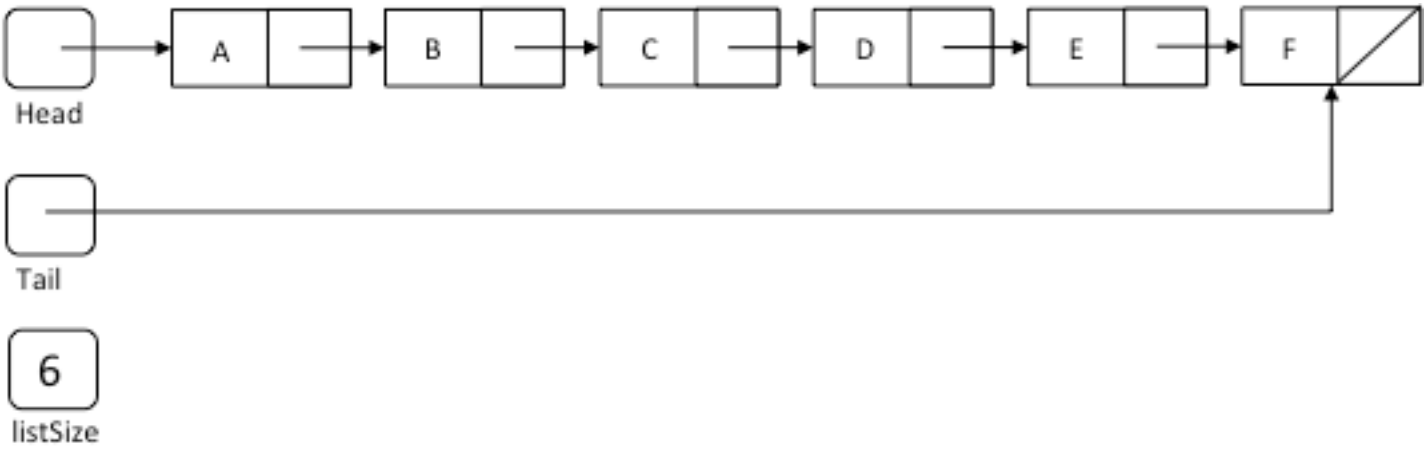
3. (50 Points) Given the following QueueInterface and Node implementation:

```
import java.util.Vector;

public interface QueueInterface {
   // returns true if Queue is empty
   // returns false otherwise
   public boolean isEmpty();

   // returns the size of the Queue
   public int size();

   // adds the specified Object
   // to the Queue
   public void add(Object obj);

   // removes and returns the front
   // of the Queue
   public Object remove();

   // tests if this Queue is equal to the
   // Queue specified by oQueue
   // Two Queues are equal if they have
   // the same size and all their elements
   // are equal
   public boolean equals(Object oQueue);

   // return a Vector containing all the
   // elements in the Queue
   public Vector<Object> peekAll();
}
```

```
public class Node {
   private Object object;
   private Node next;

   public Node(Object object) {
         this.object = object;
         this.next = null;
   }

   public Node getNext() {
         return next;
   }

   public void setNext(Node next) {
         this.next = next;
   }

   public Object getObject() {
         return object;
   }
}
```

Write the complete Java class for the reference-based LinkedQueue that implements the given QueueInterface.

4. (20 Points) Given the following list:



And the following method:

```
public void doStuff1() {
   Node[] nodes = new Node[listSize];

   Node node = head;
   int i = 0;
   while (node != null) {
      nodes[i++] = node;
      node = node.getNext();
   }

   for ( i = 0 ; i < listSize ; i += 2 ) {
      nodes[i+1].setNext(nodes[i]);
   }

   for ( i = (listSize - 1) ; i > 1 ; i -= 2 ) {
      nodes[i-3].setNext(nodes[i]);
   }

   head = nodes[1];
   tail = nodes[listSize - 2];
   nodes[listSize-2].setNext(null);
}
```

Draw the list after `doStuff1()` has finished executing.

Version 2

Instructions

- **Write your name and version number on the top of the yellow paper.**
- **Answer all questions on the yellow paper.**
- **One question per page.**
- **Use only one side of the yellow paper.**

1. (16 Points) Multiple Choice:

A. (2 Points) Which of these expressions is illegal in Java?

a. x++ 5
b. x =+ 5
c. x + = 5
d. x == 5

B. (2 Points) Which of the following is an example of a syntax error?

a. a program encounters an instruction to divide by zero
b. an array subscript in a program goes out of range
c. the beginning of a while loop is written as "whille" instead of "while"
d. an algorithm that calculates the monthly payment of a loan displays incorrect results

C. (2 Points) The midpoint of a sorted array can be found by _____, where first is the index of the first item in the array and last is the index of the last item in the array.

a. first / 2 + last / 2
b. first / 2 – last / 2
c. (first + last) / 2
d. (first – last) / 2

D. (2 Points) In the ADT list, when an item is deleted from position i of the list, _____.

a. the position of all items is decreased by 1
b. the position of each item that was at a position smaller than i is decreased by 1
c. the position of each item that was at a position greater than i is decreased by 1
d. the position of each item that was at a position smaller than i is increased by 1 while the position of each item that was at a position greater than i is decreased by 1

E. (2 Points) Which of the following statements deletes the node that curr references?

a. prev.setNext(curr);
b. curr.setNext(prev);
c. curr.setNext(curr.getNext());
d. prev.setNext(curr.getNext());

F. (2 Points) In a grammar, the symbol x y means _____.

a. x or y
b. x followed by y
c. x or y or both
d. x multiplied by y

G. (2 Points) If the array: {6, 21, 35, 3, 6, 2, 13} is added to a stack, in the order given, which of the following is the top of the stack?

a. 2
b. 6
c. 3
d. 13
e. 35

H. (2 Points) The _____ operation retrieves the item that was added earliest to a queue, but does not remove that item.

a. enqueue
b. dequeue
c. dequeueAll
d. peek

Version 2

2. (20 Points) Given the following StackInterface:

```
public interface StackInterface {
   public void push(Object obj);
   public Object pop();
   public Object peek();
}
```

And given the following reference-based Stack that implements StackInterface:

```
public class Node {
   private Object object;
   private Node next;

   public Node() {
      this.object = null;
      this.next = null;
   }

   public Node(Object object) {
      this.object = object;
      this.next = null;
   }

   public Node getNext() {
      return next;
   }

   public void setNext(Node next) {
      this.next = next;
   }

   public Object getObject() {
      return object;
   }
}
```

```
public class ReferenceStack {

   private Node stackPointer = null;

   @Override
   public void push(Integer obj) {
      Node newNode = new Node();
      if (stackPointer != null) {
         stackPointer = newNode.getNext();
      } else {
         newNode.setNext(stackPointer.getNext());
         stackPointer = newNode;
      }
   }

   @Override
   public void pop() {
      Object obj = null;
      if (stackPointer != null) {
         obj = stackPointer.getNext();
         stackPointer = stackPointer.getNext();
      }
   }

   @Override
   public Object peek() {
      Object obj = null;
      if (stackPointer != null) {
         obj = stackPointer.getObject();
      }
   }
}
```

Re-write the ReferenceStack class and fix the 10 syntax and logical errors.

Version 2

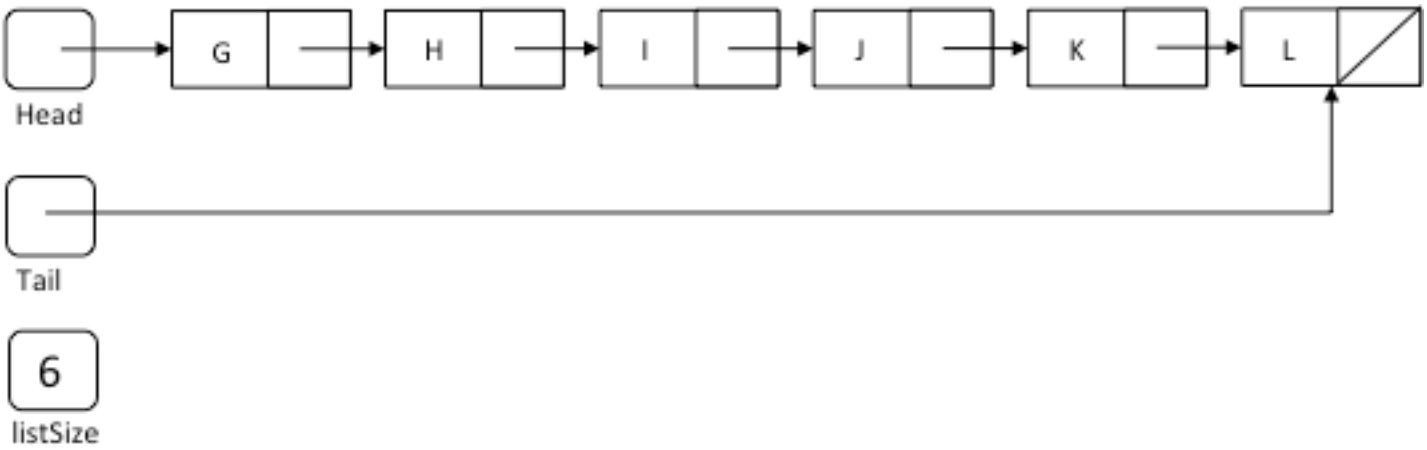
3. (50 Points) Given the following QueueInterface:

```
import java.util.Vector;

public interface QueueInterface {
   // returns true if Queue is empty
   // returns false otherwise
   public boolean isEmpty();

   // returns the size of the Queue
   public int size();

   // adds the specified Object
   // to the Queue
   public void add(Object obj);

   // removes and returns the front
   // of the Queue
   public Object remove();

   // tests if this Queue is equal to the
   // Queue specified by oQueue
   // Two Queues are equal if they have
   // the same size and all their elements
   // are equal
   public boolean equals(Object oQueue);

   // return a Vector containing all the
   // elements in the Queue
   public Vector<Object> peekAll();
}
```

Write the complete Java class for the array-based ArrayQueue that implements the given QueueInterface. You may use the Vector instead of an array in your class if you wish.

Version 2

4. (20 Points) Given the following list:



And the following method:

```
public void doStuff2() {
   Node[] nodes = new Node[listSize];

   Node node = head;
   int i = 0;
   while (node != null) {
      nodes[i++] = node;
      node = node.getNext();
   }

   for ( i = 1 ; i < listSize-1 ; i += 2 ) {
      nodes[i+1].setNext(nodes[i]);
   }

   for ( i = (listSize - 2) ; i > 2 ; i -= 2 ) {
      nodes[i-3].setNext(nodes[i]);
   }

   nodes[listSize-1].setNext(nodes[2]);
   nodes[listSize-3].setNext(nodes[0]);

   head = nodes[listSize-1];
   tail = nodes[0];
   tail.setNext(null);
}
```

Draw the list after `doStuff2()` has finished executing.

Version 3

Instructions

- **Write your name and version number on the top of the yellow paper.**
- **Answer all questions on the yellow paper.**
- **One question per page.**
- **Use only one side of the yellow paper.**

1. (16 Points) Multiple Choice:

A. (2 Points) If we wanted to write an if-statement that executes whenever the real number x is between 10.0 and 20.0, how should the test condition be written?

```
a. 10.0 < x || x > 20.0
b. 10.0 < x && x > 20.0
c. 10.0 < x && x < 20.0
d. 10.0 < x || x < 20.0
```

B. (2 Points) The communication mechanisms among modules are called _____.

```
a. algorithms
b. solutions
c. prototypes
d. interfaces
```

C. (2 Points) In a sorted array, the k^{th} smallest item is given by _____.

```
a. anArray[k-1]
b. anArray[k]
c. anArray[SIZE-k]
d. anArray[SIZE+k]
```

D. (2 Points) In the ADT list, when an item is inserted into position i of the list, _____.

```
a. the position of all items is increased by 1
b. the position of each item that was at a position smaller than i is increased by 1
c. the position of each item that was at a position greater than i is increased by 1
d. the position of each item that was at a position smaller than i is decreased by 1 while the position of each item that was at a position greater than i is increased by 1
```

E. (2 Points) Which of the following statements deletes the first node of a linear linked list that has 10 nodes?

```
a. head.setNext(curr.getNext());
b. prev.setNext(curr.getNext());
c. head = head.getNext();
d. head = null;
```

F. (2 Points) If the string w is a palindrome, which of the following is true?

```
a. w minus its first character is a palindrome
b. w minus its last character is a palindrome
c. w minus its first and last characters is a palindrome
d. the first half of w is a palindrome
e. the second half of w is a palindrome
```

G. (2 Points) If the array: {6, 2, 7, 13, 5, 4} is added to a queue, in the order given, which number will be the first number to be removed from the queue?

```
a. 6
b. 2
c. 5
d. 4
```

H. (2 Points) Operations on a queue can be carried out at _____.

```
a. its front only
b. its back only
c. both its front and back
d. any position in the queue
```

Version 3

2. (20 Points) Given the following QueueInterface:

```
public interface QueueInterface {
   public void add(Object obj);
   public Object remove();
   public Object peek();
}
```

And given the following array-based ArrayQueue that implements QueueInterface:

```
import java.util.Vector;

public class ArrayQueue {

   private Vector<Integer> queueVector = new Vector<Object>();

   @Override
   public void add(Object obj) {
      queueVector.addElement(null);
   }

   @Override
   public void remove() {
      Object obj = null;
      if (queueVector.size() <= 0) {
         obj = queueVector.elementAt(1);
         queueVector.remove(0);
      }
   }

   @Override
   public void peek() {
      Object obj = null;
      if (queueVector.size() > 0) {
         obj = queueVector.elementAt(1);
      }
   }
}
```

Re-write the ArrayQueue class and fix the 10 syntax and logical errors.

Version 3

3. (50 Points) Given the following StackInterface and Node implementation:

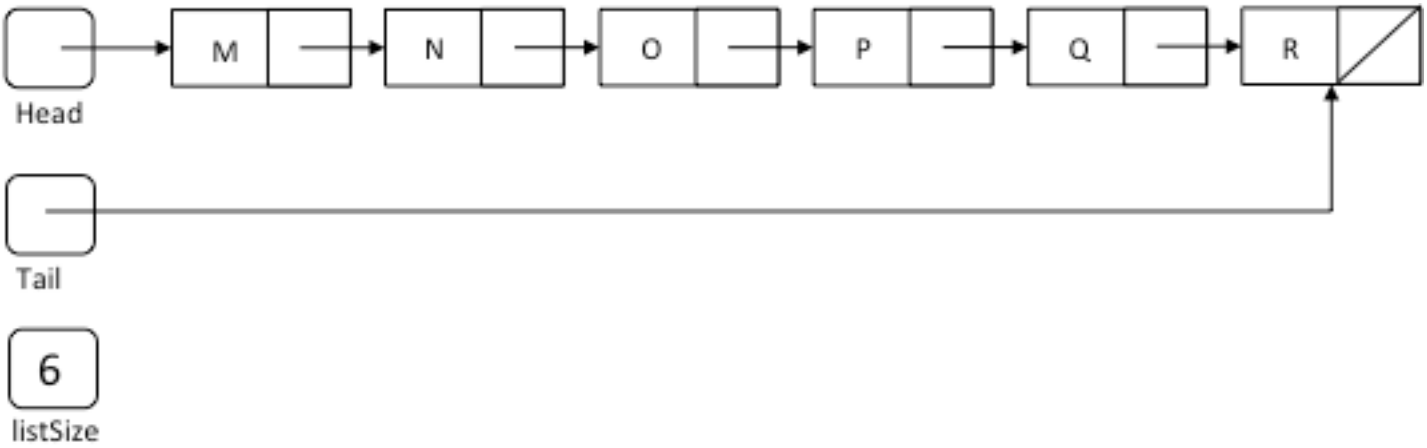
```
import java.util.Vector;

public interface StackInterface {
    // returns true if Queue is empty
    // returns false otherwise
    public boolean isEmpty();

    // returns the size of the Queue
    public int size();

    // pushed the specified Object
    // onto the stack
    public void push(Object obj);

    // pops and returns the Object
    // at the top of the stack
    public Object pop();

    // tests if this Stack is equal to the
    // Stack specified by oStack
    // Two Stacks are equal if they have
    // the same size and all their elements
    // are equal
    public boolean equals(Object oStack);

    // returns a Vector containing all the
    // elements in the Stack
    public Vector<Object> peekAll();
}
```

```
public class Node {
    private Object object;
    private Node next;

    public Node(Object object) {
            this.object = object;
            this.next = null;
    }

    public Node getNext() {
            return next;
    }

    public void setNext(Node next) {
            this.next = next;
    }

    public Object getObject() {
            return object;
    }
}
```

Write the complete Java class for the reference-based LinkedStack that implements the given StackInterface.

Version 3

4. (20 Points) Given the following list:



And the following method:

```
public void doStuff3() {
   Node[] nodes = new Node[listSize];

   Node node = head;
   int i = 0;
   while (node != null) {
      nodes[i++] = node;
      node = node.getNext();
   }

   for ( i = (listSize - 1) ; i > 0 ; i-- ) {
      nodes[i].setNext(nodes[i-1]);
   }

   head = nodes[listSize - 1];
   tail = nodes[0];
   tail.setNext(null);
}
```

Draw the list after `doStuff3()` has finished executing.

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Version 4

Instructions

- **Write your name and version number on the top of the yellow paper.**
- **Answer all questions on the yellow paper.**
- **One question per page.**
- **Use only one side of the yellow paper.**

1. (16 Points) Multiple Choice:

A. (2 Points) If s1 is of type String, what does s1.compareTo(s1) return?

a. zero
b. true
c. false
d. Cannot be determined without knowing the value of s1.

B. (2 Points) Which of the following is an example of a logical error?

a. an algorithm that calculates the monthly payment of a loan displays incorrect results
b. an array subscript in a program goes out of range
c. a program expects a nonnegative number but reads –23
d. the beginning of a while loop is written as "whille" instead of "while"

C. (2 Points) The factorial of n is equal to _____.

a. n – 1
b. n – factorial (n–1)
c. factorial (n–1)
d. n * factorial (n–1)

D. (2 Points) In the following list {John, Kate, Fred, Mark, Jon, Adam, Drew} which element does not have a predecessor?

a. John
b. Mark
c. Drew
d. Kate

E. (2 Points) Which of the following statements is used to insert a new node, referenced by newNode, at the end of a linear linked list?

a.
```
newNode.setNext(curr);
prev.setNext(newNode);
```
b.
```
newNode.setNext(head);
head = newNode;
```
c.
```
prev.setNext(newNode);
```
d.
```
prev.setNext(curr);
newNode.setNext(curr);
```

F. (2 Points) The symbol A^nB^n is standard notation for the string that consists of _____.

a. an A, followed by an n, followed by a B, followed by an n
b. an equal number of A's and B's, arranged in a random order
c. n consecutive A's, followed by n consecutive B's
d. a pair of an A and a B, followed another pair of an A and a B

G. (2 Points) The last-in, first-out (LIFO) property is found in the ADT _____.

a. list
b. stack
c. queue
d. tree

H. (2 Points) In a queue, items can be added _____.

a. only at the front of the queue
b. only at the back of the queue
c. either at the front or at the back of the queue
d. at any position in the queue

Version 4

2. (20 Points) Given the following QueueInterface:

```
public interface QueueInterface {
    public void add(Object obj);
    public Object remove();
}
```

And given the following reference-based Queue that implements QueueInterface:

```
public class Node {
    private Object object;
    private Node next;

    public Node(Object object) {
            this.object = object;
            this.next = null;
    }

    public Node getNext() {
            return next;
    }

    public void setNext(Node next) {
            this.next = next;
    }

    public Object getObject() {
            return object;
    }
}
```

```
public class ReferenceQueue implements QueueInteface {

    private Node front = null, back = null;

    @Override
    public void add(Object obj) {
            Node newNode = new Node(obj);
            if (back != null) {
                    front = newNode;
                    back = front;
            } else {
                    back.setNext(newNode);
                    back = newNode;
            }
    }

    @Override
    public Integer remove() {
            Object obj = null;
            if (front == null) {
                    obj = front.getObject();
                    front = front.getNext();
            }
            if (front != null) {
                    back = null;
            }
            return null;
    }
}
```

Re-write the ReferneceQueue class and fix all syntax and logical errors.

Version 4

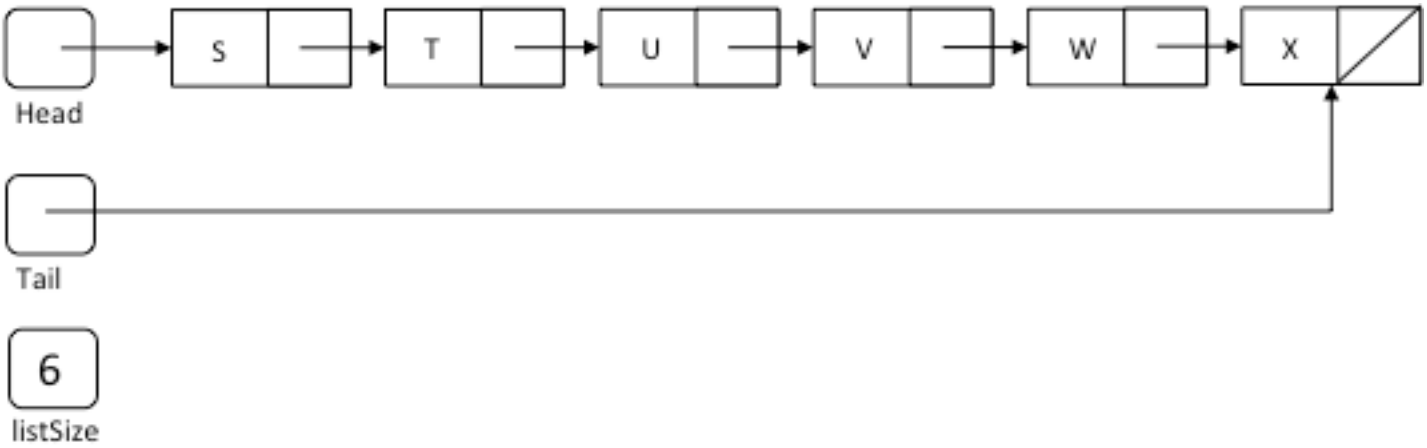
3. (50 Points) Given the following StackInterface:

```
import java.util.Vector;

public interface StackInterface {
   // returns true if Queue is empty
   // returns false otherwise
   public boolean isEmpty();

   // returns the size of the Queue
   public int size();

   // pushed the specified Object
   // onto the stack
   public void push(Object obj);

   // pops and returns the Object
   // at the top of the stack
   public Object pop();

   // tests if this Stack is equal to the
   // Stack specified by oStack
   // Two Stacks are equal if they have
   // the same size and all their elements
   // are equal
   public boolean equals(Object oStack);

   // returns a Vector containing all the
   // elements in the Stack
   public Vector<Object> peekAll();
}
```

Write the complete Java class for the array-based ArrayStack that implements the given StackInterface. You may use the Vector instead of an array in your class if you wish.

Version 4

4. (20 Points) Given the following list:



And the following method:

```
public void doStuff4() {
   Node[] nodes = new Node[listSize];

   Node node = head;
   int i = 0;
   while (node != null) {
      nodes[i++] = node;
      node = node.getNext();
   }

   for ( i = 1 ; i < (listSize - 3) ; i++ ) {
      nodes[i].setNext(nodes[i+2]);
   }

   for ( i = (listSize - 1) ; i > 3 ; i-- ) {
      nodes[i].setNext(nodes[i-4]);
   }

   nodes[0].setNext(nodes[listSize - 1]);

   head = nodes[2];
   tail = nodes[3];
   tail.setNext(null);
}
```

Draw the list after `doStuff4()` has finished executing.