	King Saud University	College of Computer and Information Sciences Department of Computer Science
	Data Structures CSC 212	**Practice Midterm Exam Solution - Spring 2019**
	Date: ——	Duration: 90 minutes

Guidelines

•No calculators or any other electronic devices are allowed in this exam.

Student ID:	Name:
Section:	Instructor:

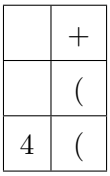
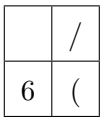
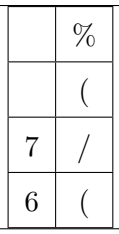
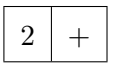
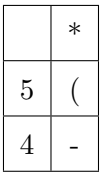
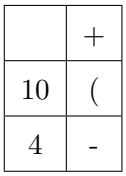
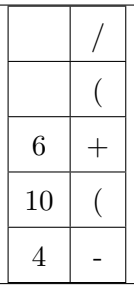
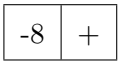
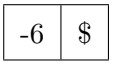
1	2	3.1	3.2	Total

Question 1 ..... 30 points

1. Trace the execution of the following expression: **8 6 4 - / 6 4 3 % 2 + - > 8 7 2 1 - + ≠ &&**. Show the content of the data structure(s) **after** parsing each operation.

-	/	%	+	-
2 8	4	1 6 4	3 6 4	3 4
>	-	+	≠	&&
T	1 7 8 T	8 8 T	F T	F

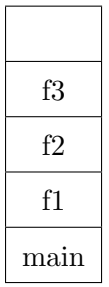
2. Trace the execution of the following expression: **((4 + 2) / (7 % 4)) + 2 - (5 * 2 +(6 / 3)) +2**. Draw the content of the data structure(s) after parsing each operation.

+	/	%	+	-
				
*	+	/	+	$
				

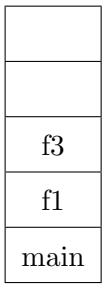
3. Consider the following code:

```
public static void f1(int n) {
  n++;
  f3(n);
  f2(n);
  f3(n); }
public static void f2(int n) {
  f3(n);
  n++;
  f3(n); }
public static void f3(int n) {
  System.out.println(n); }
public static void main(String[] args) {
  int n = 3;
  f2(n);
  n++;
  f1(n); }
```

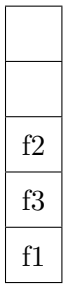
For each snapshot of the call stack below, indicate if it is valid for this code.



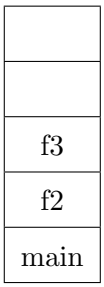
Ⓐ Yes Ⓑ No



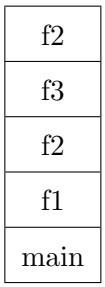
Ⓐ Yes Ⓑ No



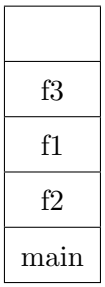
Ⓐ Yes Ⓑ No



Ⓐ Yes Ⓑ No



Ⓐ Yes Ⓑ No



Ⓐ Yes Ⓑ No

Question 2 ..... 15 points

1. To solve the problem, we can use a data structure similar to a queue, where in addition to the data, we keep track of the frequency of each element. We will call this ADT: FreqQueue. It has the following

specification:

Domain:

- Data: generic, T.
- Structure: linear.

Operations: All operations are done on a FreqQueue fq.

- – procedure length(int: n)
  - Requires: none.
  - Result: Returns the number of elements in fq.
  - Output: `n`.
- – procedure full(boolean: f)
  - Requires: none.
  - Result: Returns true if fq is full, false otherwise.
  - Output: `f`.
- – procedure add(T: e)
  - Requires: fq is not full.
  - Result: If e does not exist in fq, then it is added at the end of fq with frequency 1, otherwise the frequency of e is incremented by 1.
  - Output: none.
- – procedure serve(T: e, int: f)
  - Requires: fq is not empty.
  - Result: the first element in fq is removed, its value is assigned to e, and its frequency is assigned to f.
  - Output: e, f.

2.
```
public interface FreqQueue<T> {
  int length();

  boolean full();

  void add(T e);

  FreqQueueElem<T> serve();
}
```

The return type of the method `serve` is :

```
public class FreqQueueElem<T> {
  public T data;
  public int freq;

  public FreqQueueElem(T data, int freq) {
    this.data = data;
    this.freq = freq;
  }
}
```

Question 3 . . . . . 55 points

1.

```
import java.util.Random;

public class ArrayRandomSet<T> implements RandomSet<T> {
  private T[] data;
  private int n, maxSize;
  private Random rnd;

  public ArrayRandomSet(int maxSize) {
    this.maxSize = maxSize;
    n = 0;
    data = (T[]) new Object[maxSize];
    rnd = new Random();
  }

  @Override
  public int size() {
    return n;
  }

  @Override
  public boolean full() {
    return n == maxSize;
  }

  @Override
  public boolean add(T e) {
    for (int i = 0; i < n; i++) {
      if (e.equals(data[i])) {
        return false;
      }
    }
    data[n] = e;
    n++;
    return true;
  }

  @Override
  public T remRandom() {
    int k = rnd.nextInt(n);
    T e = data[k];
    data[k] = data[n - 1];
    n--;
    return e;
  }
}
```

2.

```
public static <T> boolean find(RandomSet<T> s, T e) {
  int n = s.size();
  RandomSet<T> ts = new ArrayRandomSet<T>(n);
  boolean found = false;
  for (int i = 0; i < n; i++) {
    T tmp = s.remRandom();
    ts.add(tmp);
    if (e.equals(tmp)) {
      found = true;
      break;
    }
  }

  while (ts.size() > 0) {
    s.add(ts.remRandom());
  }
  return found;
}
```