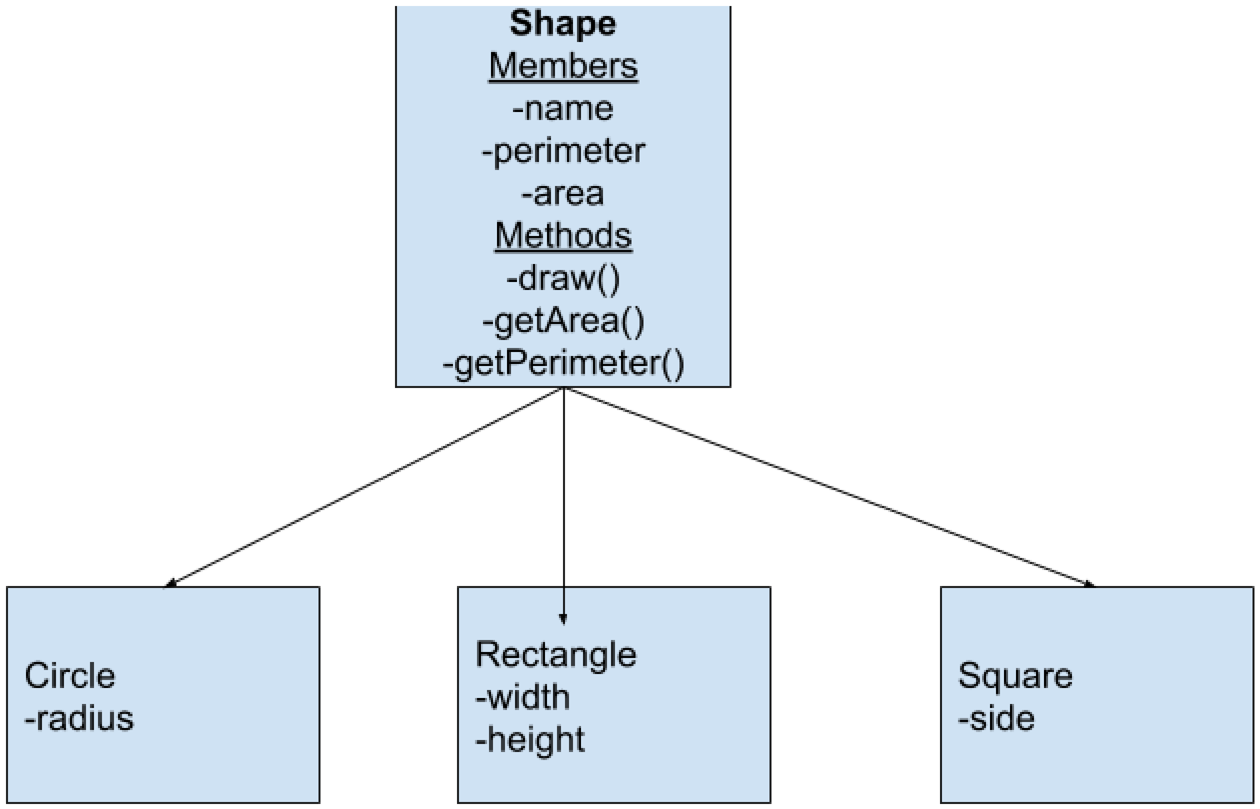
Deadline: 7th October 2019, 11:59pm

Q1. Implement the following four classes using Inheritance (2 mks)



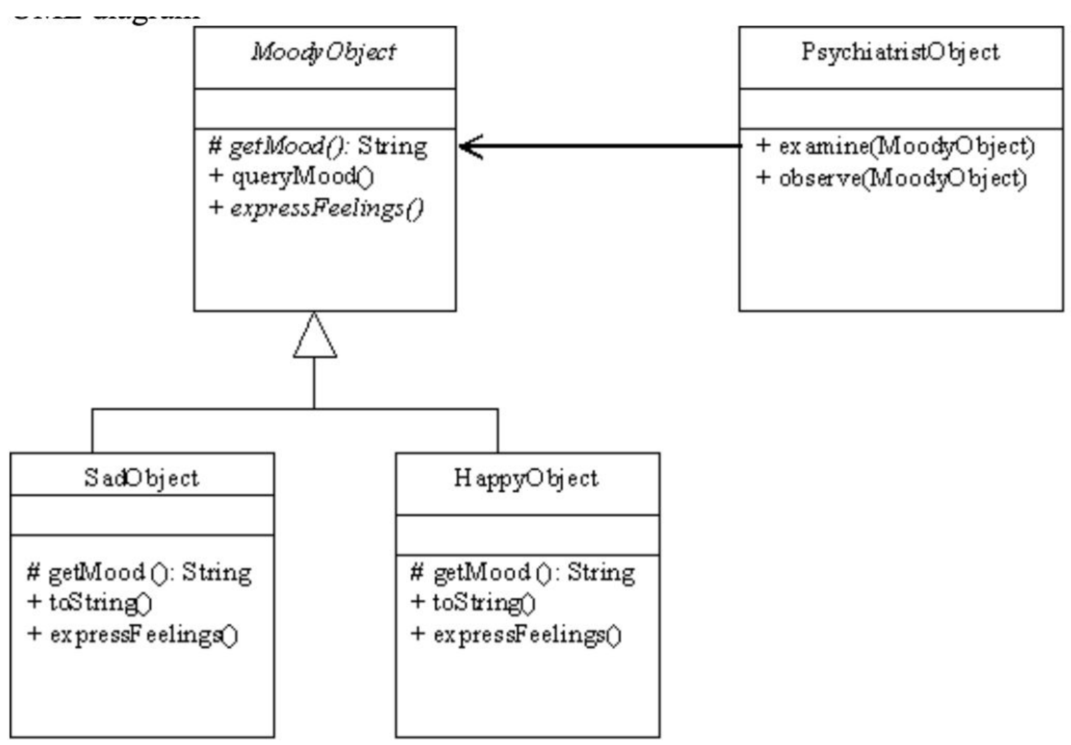
Use the following class to test your classes.

```
public class ShapeTester
{
  //Main operation class for testing
  public static void main(String args[])
  {
          Shape s = new Shape();
          Rectangle r = new Rectangle(2.0, 3.0);
          Circle c = new Circle(4.0);
          Square sq = new Square(4.0);

          r.getArea();  // should print 6.0
          r.getPerimeter(); // should print 10.0
          c.getArea(); // should print 50.26
          c.getPerimeter(); // should print 25.13
          sq.getArea(); // should print 16.0
          sq.getPerimeter(); // should print 16.0
          r.draw(); // should print “Drawing rectangle”
```

```
        c.draw(); // should print "Drawing Circle"
        s.draw(); // should print "Drawing Shape"
        sq.draw(); // should print "Drawing Square"
    }
}
```

Q2. For this problem you will write a Java program that uses polymorphism and abstract classes and methods. The program should implement the design indicated in this UML diagram
(3mks)



MoodyObject:

```
//returns the mood: sad or happy - depending on which object sends the message
protected abstract String getMood();


//each object expresses a different emotion
```

protected abstract void expressFeelings();

//an object responds according to how it feels, print "I feel happy(or sad) today!"

public void queryMood() {

SadObject:

//returns a string indicating sad

protected String getMood();

//print crying string: " 'wah' 'boo hoo' 'weep' 'sob' 'weep' "

public void expressFeelings();

//returns message about self: "Subject cries a lot";

public String toString();

HappyObject:

//returns a string indicating happy

protected String getMood();

//print laughter string: "hehehe...hahahah...HAHAHAHAHA!!!"

public void expressFeelings();

//returns message about self: "Subject laughs a lot"

public String toString();

PsychiatristObject:

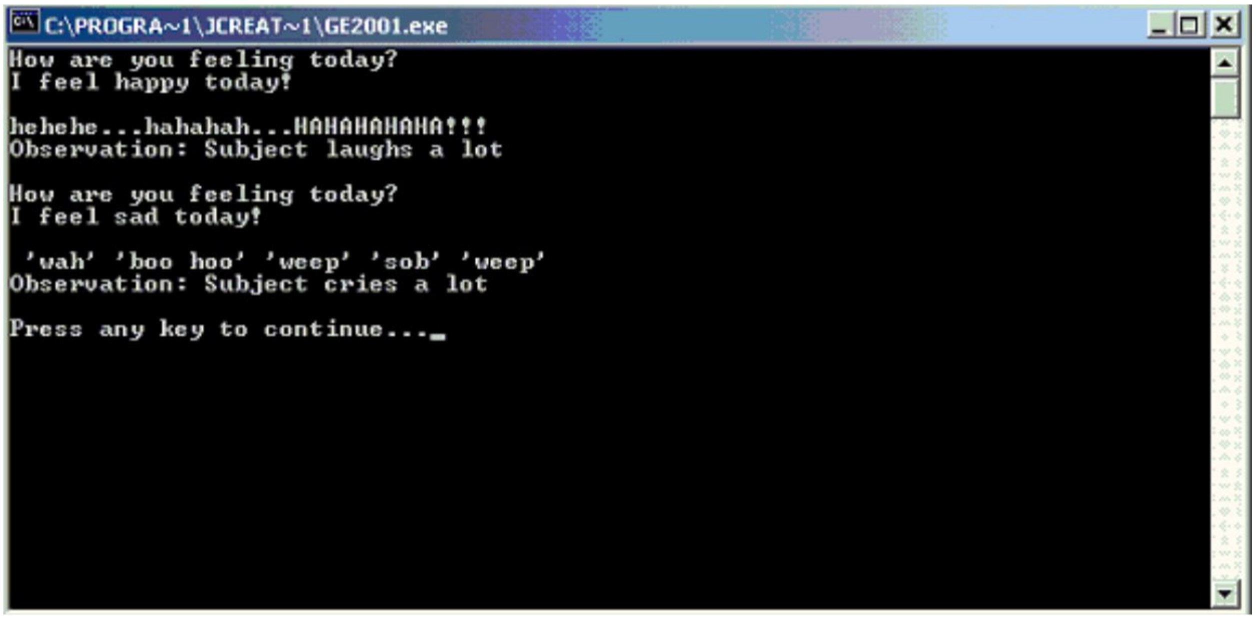
//asks a moody object about its mood

public void examine(MoodyObject moodyObject);

//a moodyObject is observed to either laugh or cry

public void observe(MoodyObject moodyObject);

Write a main() method that creates a psychiatrist object and two moodyObjects. The psychiatrist object will examine and observe each moodyObject. The output of your program should be same with the following output:


C:\PROGRA~1\JCREAT~1\GE2001.exe

```
How are you feeling today?
I feel happy today!

hehehe...hahahah...HAHAHAHAHA!!!
Observation: Subject laughs a lot

How are you feeling today?
I feel sad today!

 'wah' 'boo hoo' 'weep' 'sob' 'weep'
Observation: Subject cries a lot

Press any key to continue..._
```

Q3. (4 mks)You will be writing code in support of a DessertShop which sells candy by the pound, cookies by the dozen, ice cream, and sundaes (ice cream with a topping). Your software will be used for the checkout system.

To do this, you will implement an inheritance hierarchy of classes derived from a DessertItem abstract superclass.

The Candy, Cookie, and IceCream classes will be derived from the DessertItem class.

The Sundae class will be derived from the IceCream class.

You will also write a Checkout class which maintains a list (Vector) of DessertItems.

The DessertItem Class

The DessertItem class is an abstract superclass from which specific types of DessertItems can be derived. It contains only one data member, a name. It also defines a number of methods. All of the DessertItem class methods except the *getCost()* method are defined in a generic way in the file Class-DessertItem, provided for you along with the other homework specific files in the directory. The *getCost()* method is an abstract method that is not defined in the DessertItem class because the method of determining the costs varies based on the type of item. Tax amounts should be rounded to the nearest cent. For example, calculating the tax on a food item with a cost of 199 cents with a tax rate of 2.0% should be 4 cents. The complete specifications for the DessertItem class are provided in the file Class-DessertItem.

The DessertShop Class

The DessertShop class contains constants such as the tax rate as well as the name of the store, the maximum size of an item name and the width used to display the costs of the items on the receipt. Your code should use these constants wherever necessary! The DessertShop class also contains the *cents2dollarsAndCentsmethod* which takes an integer number of cents and returns it as a String formatted in dollars and cents. For example, 105 cents would be returned as "1.05".

The Derived Classes

All of the classes which are derived from the DessertItem class must define a constructor. The TestCheckout class determine the parameters for the various constructors. Each derived class should be implemented by creating a file with the correct name, eg., Candy.java.

The Candy class should be derived from the DessertItem class. A Candy item has a *weight* and a *price per pound* which are used to determine its *cost*. For example, 2.30 lbs.of fudge @ .89 /lb. = 205 cents. The cost should be rounded to the nearest cent.

The Cookie class should be derived from the DessertItem class. A Cookie item has a *number* and a *price per dozen* which are used to determine its *cost*. For example, 4 cookies @ 399 cents /dz. = 133 cents. The cost should be rounded to the nearest cent.

The IceCream class should be derived from the DessertItem class. An IceCream item simply has a *cost*.

The Sundae class should be derived from the IceCream class. The *cost* of a Sundae is the *cost* of the IceCream plus the *cost of the topping*.

The Checkout Class

The Checkout class provides methods to enter dessert items into the cash register, clear the cash register, get the number of items, get the total cost of the items (before tax), get the total tax for the items, and get a String representing a receipt for the dessert items. The Checkout class must use a Vector to store the DessertItems. The total tax should be rounded to the nearest cent. The complete specifications for the Checkout class are provided in the file Class-Checkout.

Testing

A simple testdriver, TestCheckout.java along with its expected output, are provided for you to test your class implementations. You can add additional tests to the driver to more thoroughly test your code.

TestCheckOut

```
public class TestCheckOut {

    public static void main(String[] args) {

        Checkout checkout = new Checkout();

        checkout.enterItem(new Candy("Peanut Butter Fudge", 2.25, 399));
        checkout.enterItem(new IceCream("Vanilla Ice Cream", 105));
        checkout.enterItem(new Sundae("Choc. Chip Ice Cream", 145, "Hot Fudge",
50));
        checkout.enterItem(new Cookie("Oatmeal Raisin Cookies", 4, 399));
        System.out.println("\nNumber of items: " + checkout.numberOfItems() +
"\n");
        System.out.println("\nTotal cost: " + checkout.totalCost() + "\n");
        System.out.println("\nTotal tax: " + checkout.totalTax() + "\n");
        System.out.println("\nCost + Tax: " + (checkout.totalCost() +
checkout.totalTax()) + "\n");
        System.out.println(checkout);

        checkout.clear();

        checkout.enterItem(new IceCream("Strawberry Ice Cream", 145));
        checkout.enterItem(new Sundae("Vanilla Ice Cream", 105, "Caramel",
50));
        checkout.enterItem(new Candy("Gummy Worms", 1.33, 89));
        checkout.enterItem(new Cookie("Chocolate Chip Cookies", 4, 399));
        checkout.enterItem(new Candy("Salt Water Taffy", 1.5, 209));
        checkout.enterItem(new Candy("Candy Corn", 3.0, 109));

        System.out.println("\nNumber of items: " + checkout.numberOfItems() +
"\n");
        System.out.println("\nTotal cost: " + checkout.totalCost() + "\n");
        System.out.println("\nTotal tax: " + checkout.totalTax() + "\n");
        System.out.println("\nCost + Tax: " + (checkout.totalCost() +
checkout.totalTax()) + "\n");
        System.out.println(checkout);
    }
}
```

Output

```
Number of items: 4

Total cost: 1331

Total tax: 87

Cost + Tax: 1418


      M & M Dessert Shop
      --------------------

2.25 lbs. @ 3.99 /lb.
Peanut Butter Fudge            8.98
Vanilla Ice Cream              1.05
```

```
Hot Fudge Sundae with
Choc. Chip Ice Cream                1.95
4 @ 3.99 /dz.
Oatmeal Raisin Cookies              1.33

Tax                           .87
Total Cost                  14.18


Number of items: 6

Total cost: 1192

Total tax: 77

Cost + Tax: 1269


      M & M Dessert Shop
      --------------------

Strawberry Ice Cream                1.45
Caramel Sundae with
Vanilla Ice  Cream            1.55
1.33 lbs. @ .89 /lb.
Gummy Worms                   1.18
4 @ 3.99 /dz.
Chocolate Chip Cookies              1.33
1.50 lbs. @ 2.09 /lb.
Salt Water Taffy              3.14
3.00 lbs. @ 1.09 /lb.
Candy Corn                    3.27

Tax                           .77
Total Cost                  12.69
```

Q4. (1 mark) Given two matrices **A** and **B**, return the result of **AB**.
You may assume that **A**'s column number is equal to **B**'s row number.

Example:

```
Input:

A = [
  [ 1, 0, 0],
  [-1, 0, 3]
]
```

```
B = [
  [ 7, 0, 0 ],
  [ 0, 0, 0 ],
  [ 0, 0, 1 ]
]

Output:

     |  1 0 0 |   | 7 0 0 |   |  7 0 0 |
AB = | -1 0 3 | x | 0 0 0 | = | -7 0 3 |
                  | 0 0 1 |
```

Q5. (Extra Credit- 2 mks)

Given a string `S` that **only** contains "I" (increase) or "D" (decrease), let `N = S.length`.

Return **any** permutation `A` of `[0, 1, ..., N]` such that for all `i = 0, ..., N-1`:

- If `S[i] == "I"`, then `A[i] < A[i+1]`
- If `S[i] == "D"`, then `A[i] > A[i+1]`

Example 1:

```
Input: "IDID"

Output: [0,4,1,3,2]
```

Example 2:

```
Input: "III"

Output: [0,1,2,3]
```

Example 3:

```
Input: "DDI"

Output: [3,2,0,1]
```

Note:

1. `1 <= S.length <= 10000`
2. `S` only contains characters `"I"` or `"D"`.