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CS 100J Prelim 2 *We'll try to have grades posted by 1AM!!* 16 October 2007

This 90-minute exam has 6 questions (numbered 0..5) worth a total of 100 points. Spend a few minutes looking at all questions before beginning. Use the back of the pages if you need more space.

Question 0 (2 points). Fill in the information, legibly, at the top of *each* page. (Hint: do it now.)

Question 1 (15 points). Write the body of the following function.

Here are the ground rules:
1. Do not write any other method.
2. Use recursion; do not use a loop.
3. Do not declare a local String variable or use any String function.
4. You will have to use String operation *catenation* (+).

```
/** = n, as a String, but with its digits reversed.
        Precondition: n >= 0.
        e.g. if n = 135720, the value returned is "027531".
        e.g. if n = 12345, the value returned is "54321".
        e.g. if n = 7, the value returned is "7".
        e.g. if n = 0, the value returned is "0".*/
public static String rev(int n) {










}
```

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Question 2 (30 points): This question and the next deals with classes that maintain information about bees. On the bottom right of this page is a class `Bee`, with some parts of it not yet completed. Yes, we are going to have tags to distinguish bees, as strange as that may sound.

Answer the following questions.

A. Look at the second constructor, the one at the top of the righthand column. Notice that the new `Bee` object is supposed to be given a unique tag —in field `tag`. Your job is to implement the rest of the method body of the second constructor to accomplish this. You can declare a static variable in the class to help you accomplish this task, if you wish. If you do declare a variable, be sure to explain in a comment what it means.

B. Complete the body of the first constructor. The body should be a single statement. Writing more than one statement gets you at most half credit.

C. Suppose the following function, `equals`, is to be placed within class `Bee`. Complete the body of the function. Note that field `tag` should not be tested.

```
/** = obj is an object of class Bee and has the same month and year of birth as this Bee. */
public boolean equals(Object obj) {









}
```

```
/** An instance represents a Bee */
public class Bee {




   private int month; // month of birth
   private int year; // year of birth

   private int tag;  // unique number >= 0.
                     // No two Bees have the
                    //  same tag.

   /** Constructor: A bee with birth month 1
       and birth year 0. The bee is given a
       unique tag. */
   public Bee() {


   } //continued in next column
```

```
/** Constructor:  A bee with birth month m and
        birth year y. The bee is given a unique tag.
        Precondition: 1 <= m <= 12. */
   public Bee(int m, int y) {
      month= m;
      year= y;




   }
   /** = this Bee's year of birth */
   public int getYOB() { return year; }

   /** = this Bee's month of birth */
   public int getMOB() { return month; }

   /** = this Bee's tag (-1 if none)= */
   public int getTag() { return tag; }
}
```

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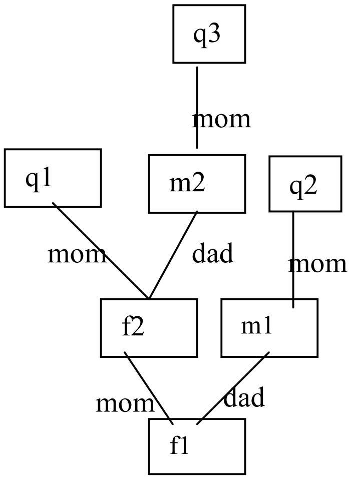
Question 3 (18 points). Did you know that a male bee has a mother but *not* a father? But a female bee has both a father and a mother. A queen bee is represented by an object of class `Bee` (previous question), and we don't know her mother and father. A male bee is represented by an object of class `MaleBee`, shown below. A female bee that is not a queen is represented by an object of class `FemaleBee`, shown below. All parents of all bees are known, except for queens.



To the right is part of a family tree. Parents of queens (`q1`, `q2`, `q3`) are not known. Males (`m1`, `m2`) have only a mother. Non-queen females (`f1`, `f2`) have both a mom and a dad.

Write the body of the following function. Use recursion. Do not loops. An *ancestor* is a mother, father, grandmother, grandfather, etc.

Besides the necessary recursion, think also about issues like these: (1) How do you tell the base case (i.e. that `b` is a queen)? (2) If `b` is not a queen, how do you cast it to the proper class so that its methods can be used?

Use the back of another page if you want. You can separate the pages.

```
/** = number of female ancestors of bee b.
      Precondition: b is not null. */
public static int femAnc(Bee b) {









}
```

```
/** A male bee */
public class MaleBee extends Bee {

   private Bee mother; // mother of this bee

   /** Constructor: A male bee with birth date
         month and year and mother mom.
         Precondition: mom is not null. */
   public MaleBee(int month, int year,
                                    Bee mom) {
      super(month, year);
      mother= mom;
   }

   /** = the mother of this bee */
   public Bee getMother() { return mother; }
}
```

```
/** A female bee (that is not a queen) */
public class FemaleBee extends Bee {
   private Bee mother; // mother of this bee
   private MaleBee father; // father of this bee

   /** Constructor: A female bee with birth date
        month/year, mother mom, and father dad.
        Precondition: mom and dad are not null. */
   public FemaleBee(int month, int year,
                         Bee mom, MaleBee dad) {
      super(month, year);
      mother= mom;
      father= dad;
   }

   /** = the mother of this bee */
   public Bee getMother() { return mother; }

   /** = the father of this bee */
   public Bee getFather() { return father; }
}
```

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Question 4. (15 points).

(a) Write the four steps in evaluating a function call.

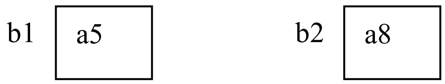
(b) To the right is part of class Bee of a previous question, with just enough of it for you to answer this question and an additional function isOlder.

```
/** An instance represents a Bee */
public class Bee {
   private int month; // month of birth
   private int year; // year of birth

   /** Constructor: A bee with birth month 1
        and birth year 0. The bee is given a
        unique tag. */
   public Bee() { … }

  /** = "this bee is older than b". */
   public boolean isOlder(Bee b) {
      boolean x= year < b.year;
      boolean y= year == b.year  &&
                 month < b.month;
      return x || y;
   }
```

Suppose variable b1 and b2 contain the names of Bee objects, as shown here:



Draw the frame for the following call, including its scope box.

```
b1.isOlder(b2)
```

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0	___________	out of 02
1	___________	out of 15
2	___________	out of 30
3	___________	out of 18
4	___________	out of 15
5	___________	out of 20
Total	________	out of 97

Question 5 (20 points). **(a)** Consider this function.

```
public void f(int p) {
  p= p + 1;
  if (p < 0) {
       int k= p;
        p= p + k;
  }
}
```

When are parameter `p` and local variable `k` created?

(b) What is an argument?

(c) Consider the following statement, where class `Bee` is given on page 2 and class `MaleBee` on page 3:

```
Bee b= new MaleBee(5, 2007, bmom);
```

What are the *apparent* and *real* classes of `b` after execution of this statement?

(d) Suppose `b` using the assignment in part (c). Indicate which of the following three expressions are syntactically legal or illegal. For an illegal one, explain why it is illegal; then, if is possible to change it so that it is legal (and returns the obviously desired value), do so; if it is not possible, explain why.

```
b.getTag()
```

```
b.getMother()
```

```
b.getFather()
```