The final exam for this course is scheduled for Friday December 10, at 8:30 AM. It will be held in our regular classroom, Coxe 7. The exam will be six pages long and will take most people less than one-and-a-half hours. However, you can use up to the full three-hour exam period if necessary.

The exam is cumulative, with some emphasis on material that was covered since the second test. The final exam counts for 15% of your grade for the course.

The first five pages of the exam will be similar to previous tests, with a mix of definitions and short essay questions, programming problems, and questions that ask you to understand and interpret Java code. You will not be asked to write any sorting subroutine, or to write GUI code except possibly for basic drawing on a Canvas. (There might be essay questions about GUI concepts, and you might be given some GUI code and asked to explain it.)

The last question on the exam will be a full-page, twenty-point essay question on the topic of program development and how it is supported by the Java programming language. Topics related to program development include pseudocode, step-wise refinement, subroutines, top-down and bottom-up design, object-oriented programming, design of classes and class hierarchies, state variables, and the design of event-driven GUI programs. You should be prepared to write a coherent and thoughtful essay on this topic.

Don't forget that solutions to tests, quizzes, and most of the labs can be found on the course web page. And answers to the end-of-chapter quizzes and exercises from the textbook are available in the web version of the book.

Some things that have been covered since the second test:

extending a class; subclasses and superclasses
inheritance
class hierarchies
polymorphism
object-oriented programming
class Object; every class is a direct or indirect subclass of Object
abstract classes and abstract methods
interfaces (i.e. the Java reserved word "interface")
the special variable "this"
using "this" to access member variables hidden by local variables
the special variable "super"
using "super" to call a method or access a variable from the superclass
nested classes
GUI programming: components, layout, and events
ArrayList and parameterized types
for-each loops; using for-each loops with arrays and ArrayLists
the search problem for arrays
the linear search algorithm
sorted arrays; what it means for an array to be sorted
the basic idea behind the binary search algorithm for sorted arrays
how to think about the efficiency of an algorithm
why binary search is so much faster than linear search
the basic idea of the the Selection Sort algorithm
the basic idea of the Merge Sort algorithm

why Merge Sort is so much faster than Selection Sort
the structure of two-dimensional arrays; how they are stored in memory
processing two-dimensional arrays

Important topics from earlier in the course:

algorithm
machine language, high-level programming languages, and compilers
syntax and semantics of programming languages
`public static void main(String[] args)`
literals, variables, expressions, and operators
Java's primitive types, including int, double, boolean, and char
System.out.print(x), System.out.println(), and System.out.println(x)
TextIO methods: TextIO.getln(), TextIO.getlnInt(), TextIO.getlnDouble()
Math.random(); using Math.random() to make random integers
the String type; Strings are objects
String methods: str.length(), str.charAt(i), str.equals(s1), str.indexOf(ch)

control statements: if, while, for
exceptions and the try..catch statement
how to throw an exception, and why you might want to do so
programming style rules and why they are important

arrays
base type of an array
elements of an array; referring to array elements as for example A[i]
using "new" to create arrays, for example: new int[10]
basic array processing such as summing, counting, finding a max
two-dimensional arrays; using nested for loops with two-dimensional arrays

drawing on a Canvas using a GraphicsContext, g
basic color constants like Color.RED, Color.BLUE, Color.BLACK
setting drawing colors with g.setFill(c) and g.setStroke(c)
drawing subroutines: g.strokeLine, g.strokeRect, g.fillRect, g.strokeOval, g.fillOval

subroutines and parameters; formal parameters vs. actual parameters
black boxes; separation of interface from implementation
the access modifiers "public" and "private"
return types and the return statement; void
the dual nature of classes: the static part and the non-static part
scope of a variable; local variables vs. global variables
named constants and the "final" modifier; why named constants are used
packages; importing classes from packages
top-down and bottom-up design

classes and objects
instance methods and instance variables
instance variables represent "state" of objects; methods represent "behavior"
getter and setter methods and why they are used
pointers, also known as references; the special value null
assignment and equality-testing for objects
constructors; calling a constructor with "new"; writing a constructor for a class

Some sample questions from old final exams.

Here are some questions from final exams that I have given in the past in CPSC 124. This is not meant to cover every possible topic that might be on the exam this semester, but it will give you some idea of what types of questions might be. Note that the average difficulty of the questions on the exam will be lower than the sample of questions given here.

1. Some short programming exercises...

a) Use a **for** loop to print out all the multiples of 5 from 5 to 100, with each number on a separate line.

b) Write a program segment that gets an integer from the user in the range 1 to 100 (inclusive). Use a **while** loop to make sure that the number that you get is actually in the specified range. (You can use *TextIO* for input.)

c) Write a program segment that simulates rolling a pair of dice 1,000,000 times and counts how many times the dice come up doubles (that is, how many times the values on the two dice are the same).

d) Write a code segment to simulate the following experiment: Toss a coin over and over, until it has come up *heads* ten times. At the end, print the number of times that the coin has come up *tails*.

2. Show the output of each of the following program segments:

a)
```
int x,y;
x = 100;
y = 0;
while (x > 0) {
  x = x / 2;
  System.out.println(x);
  y++;
}
System.out.println(y);
```

b)
```
int[] A,B;
A = new int[5];
B = new int[5];
A[0] = 1;
B[0] = 0;
for (int i = 1; i < 5; i++) {
  A[i] = 2 * A[i-1] + 1;
  B[i] = A[i] + B[i-1];
  System.out.prilnln(A[i] + " " + B[i]);
}
```

3. The following code, although syntactically correct, has two semantic errors that would cause exceptions at run time. The intent is to create five buttons that are initially disabled. Find the two errors and state the problem in each case.

```
Button[] buttons;
buttons = new Button[5];
for (int i = 0; i <= 5; i++) {
    buttons[i].setDisable(true);
}
```

4. Writing subroutines...

a) Write a subroutine to count the number of times that the number 17 occurs in an array of type *int[]*. (The array should be a parameter; the return value is the count.)

b) Write a subroutine named *containsAll* with return type *boolean* and two parameters of type *String*. The value of *containsAll*(*str, chars*) should be *true* if the

string *str* contains **every** character in the string *chars*. (You will need to use either nested *for* loops or the string method *indexOf*.)

c) Write a subroutine that will strip extra spaces from a string. The parameter of the subroutine is a *String*. The return value is the same string, except that every substring of consecutive spaces has been replaced by a single space. For example, using ␣ to represent a space, if the parameter is `"Goodby␣␣␣cruel␣␣world"`, then the value returned by the subroutine is `"Goodby␣cruel␣world"`. (Hint: Only include a space in the output string if the preceding character is not also a space.)

5. A class named *Item* represents an item for sale on some web site. It has an instance method named *getCost*(), with no parameters, that returns a *double* giving the cost of the item. Write a subclass of *Item* that adds an instance method *getCostWithTax*() that returns the cost of the item plus a 7% tax. (You will have to use *super*!)

6. Consider the following arrays:

```
String[] birdNames = new String[100];  // Names of 100 bird species.
String[] cityNames = new String[50];   // Names of 50 cities.
int[][] population = new int[100][50]; // Population of each bird in each city.
```

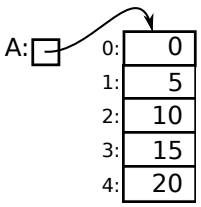
Assume that the arrays have already been filled with data. The array *population* contains data about the population of each of the 100 species of birds in each of the 50 cities. That is, *population*[*b*][*c*] is the number of birds of species number *b* that live in city number *c*.

a) Write a code segment that will add up all the numbers in the *population* array (giving the total number of birds of all species in all cities).

b) Write a code segment that will do the following for each city: **Count** the number of bird species that are found in that city (that is, the number of species for which the population is greater than zero). Then **print** the name of the city along with the number of bird species found in that city.

c) Which species of bird has the largest total population? Write a code segment that determines the answer and prints the **name** of the species.

7. Write a code segment to create the situation shown in the picture, including an array of type *int*`[]` and a variable *A* that points to the array. (Include the variable declaration.)



8. Consider the following declaration of the class *Student* and the array *stu*, and assume that the array has **already** been filled with data for 100 students. Write a code segment that prints the names of all students who have an A average, that is the average of their *test1*, *test2*, and *test3* is 90 or above.

```
public class Student {
    public String name;
    public double test1;
    public double test2;
    public double test3;
}

Student[] stu = new Student[100];
```

9. We have used the expression `(int)(1+6*Math.random())` to simulate the rolling of a standard 6-sided die, but some games use dice with different numbers of sides.

a) Write a complete Java class that represents a *single die* with any given number of sides. The class should have a constructor with no parameters that creates a standard 6-sided die. It should also have a constructor with one parameter of type *int* that specifies the number of sides of the die; the value of the parameter must be greater than 1. It should have a method for rolling the die and a method for reading the number that is currently showing on the die.

b) A certain game uses five dice, which have 4, 6, 8, 12, and 20 sides respectively. Write Java code that creates five objects belonging to the class from part **a)** to represent these five dice. You can use either five separate variables or an array to hold the data.

c) Write Java code that will roll the five dice that you created in part **b)** and print the sum of the numbers showing on the five dice.

10. Some short essay questions...

a) Define the terms *syntax* and *semantics* as they relate to programming. Include some examples in your discussion.

b) Some members of classes are *static*, and some are not. Carefully explain the difference.

c) Discuss the *new* operator, why it is necessary, and how it relates to *constructors*.

d) Describe the *binary search* algorithm, and explain briefly why it is so much more efficient than *linear search*.

e) What does it mean for a variable to be *private*, and why should private variables be used?

f) What is an algorithm? What is the difference between an algorithm and a program?

g) What are *pointers*, and where are they used in Java?

11. Write a code segment that will get two integers from the user and will print the sum of the two numbers **unless one of the numbers is 42**; if one of the numbers is 42, print the string "Don't Panic!" instead. (You can use either *Scanner* or *TextIO* for input.)

12. Write a JavaFX code segment that will draw the picture shown below. Use a *for* loop. There are exactly 11 lines in the picture. The scale that you use is up to you, but your picture should have the same form as the one that is shown. You do not have to set color or line width; just draw the lines.