1. **Exception Handling** – What is the difference between a checked exception and an unchecked exception? Give a code snippet that exemplifies each.

(0.5%+0.25%+0.25%)

**Difference**

Checked exceptions need to be handled in a try-catch block, whereas unchecked exceptions do not need to be handled in a try-catch block. Unchecked exceptions should be avoided through good programming practice.

**Checked Exception Example**

```java
try {
    FileReader fr = new FileReader("test.txt");
} catch (FileNotFoundException fnfe) {
    System.out.println("fnfe: "+fnfe.getMessage());
}
```

**Unchecked Exception Example**

```java
// a NullPointerException can be thrown if arr is null
if (arr != null) {
    for (int i=0; i < arr.length; i++) {
        System.out.println(arr[i]);
    }
}
```
2. **Serialization** – Downcasting is typically a bad programming practice. Explain the difference between downcasting and upcasting, then explain why downcasting is accepted when using serialization. (0.5% + 0.5%)

**Difference**

*Downcasting is when you typecast to a type lower than the compile-time type of a variable.*

*Upcasting is when you typecast to a type higher than the compile-time type of a variable.*

**Why is downcasting accepted when using serialization?**

*When retrieving a type that has been serialized, you need to know what the variable was. It wouldn’t make sense to just get a generic Object back, so downcasting is necessary.*

3. **AJAX and WebSockets** – WebSockets and AJAX both allow us to communicate with the server and only update a portion of the page. Name two differences between AJAX and WebSockets. (0.5% + 0.5%)

**Difference #1**

*AJAX requires the client to initiate the request, whereas WebSockets could have the request initiated by either the client or server.*

**Difference #2**

*AJAX can be implemented asynchronously or synchronously, whereas WebSockets are always synchronous.*

*Other answers may be acceptable.*
4. **Software Engineering** – Some managers may dislike pair programming because they think two programmers are being paid to do the work of one. Give two reasons that pair programming may actually save the company money in the long run. (0.5% + 0.5%)

**Reason #1**
Pair programming can reduce the number of bugs that are produced.

**Reason #2**
Pair programming can catch bugs earlier in the development process, which will save the company money.

Other answers may be acceptable.

5. **Concurrent Computing** – Your friend has a dual core single CPU machine. He told you that he wrote a parallel merge sort algorithm that runs twice as fast as the single-threaded version. Do you believe your friend? Why or why not? (0.5% + 0.5%)

This is not possible because there is overhead in spawning a thread and sending it to another core. A speedup of 2x is an absolute max, but it will never get to that.

6. **Databases** – What is the purpose of a driver when connecting a program to a database? (1.0%)

A driver contains the conversion from your program to the protocol understood by the database.
7. **Threads** – Threads have a priority that can be set, with the default priority being NORM_PRIORITY. Assume you have three threads with priorities of MIN_PRIORITY, NORM_PRIORITY, and MAX_PRIORITY, respectively. Explain what happens when the JVM needs to decide which of those threads to put into the CPU when it is performing a context switch. (1.0%)

The JVM will determine the entire priority range, which would be $1 + 5 + 10 = 16$. The JVM will then choose a number between 1 and 16. If it chooses 1, then the MIN_PRIORITY thread will get to execute. If it chooses 2 through 6, the thread with NORM_PRIORITY will get to execute. If it chooses 7 through 16, the thread with MAX_PRIORITY will get to execute.

8. **Multi-Threading and Parallel Programming** – Give two reasons why a program written using parallel computing could run more slowly than a program written using multi-threading. (0.5%+0.5%)

**Reason #1**

There is extra overhead in parallel programming since the thread must be moved to a different core than where it is currently executing. If this overhead is high, the multi-threaded program could run faster.

**Reason #2**

If the main thread needs to wait for the parallel threads to finish executing, it's possible that multi-threading would run faster since there is less overhead with multi-threading than parallel programming.

*Other answers may be acceptable.*
9. **Networking Theory** – Assume you are given the following IP address and subnet mask.

IP – 126.87.146.27  
IP – 0111 1110 0101 0111 1001 0010 0001 1011  
Subnet Mask – 255.255.248.0  
Subnet Mask – 1111 1111 1111 1111 1111 1000 0000 0000

a. What class IP address is given? (0.25%)  
   *Class A*

b. What is the network address? (0.5%)  
   126.0.0.0

c. Is the IP address public or private? (0.25%)  
   *public*

d. How many hosts can be on the network? (Exponent form is fine.) (0.5%)  
   \[2^{24} - 2 = 16,777,214\]  
   *(The exact number isn’t necessary.)*

e. How many hosts can be on the subnetwork? (Exponent form is fine.) (0.5%)  
   \[2^{11} - 2 = 2046\]

f. What is the network and subnetwork combination? (0.25% + 0.25%)  
   *Binary (only 0s and 1s)*  
   0111 1110 0101 0111 1001 0000 0000 0000  
   *Decimal*  
   126.87.144.0

g. What are the first and last IP addresses that could be assigned to hosts in the subnetwork? (0.25% + 0.25%)  
   *First Assignable IP Address* (in decimal, not binary)  
   126.87.144.1  
   *Last Assignable IP Address* (in decimal, not binary)  
   126.87.151.254
10. Locks and Monitors – Look at the following code, then answer the question that follows the code.

```java
import java.util.concurrent.locks.Lock;
import java.util.concurrent.locks.ReentrantLock;
public class Question10 extends Thread {
    private Lock l = new ReentrantLock();
    public synchronized void a() {
        try {
            l.lock();
            System.out.println("a");
        } finally {
            l.unlock();
        }
    }
    public synchronized void b() {
        try {
            l.lock();
            System.out.println("b1");
            a();
            System.out.println("b2");
        } finally {
            l.unlock();
        }
    }
    public void run() {
        b();
        a();
    }
    public static void main(String [] args) {
        Question10 q1 = new Question10();
        Question10 q2 = new Question10();
        q1.start();
        q2.start();
    }
}
```

a. Which of the following outputs are possible? Circle yes or no below the output.

\[(0.25%+0.25%+0.25%+0.25%)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>b1</td>
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<tr>
<td>b1</td>
<td>a</td>
<td>b1</td>
<td>a</td>
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<tr>
<td>a</td>
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<td>a</td>
<td>b1</td>
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<tr>
<td>a</td>
<td>a</td>
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<td>a</td>
</tr>
</tbody>
</table>

\[yes/ no \quad yes/ no \quad yes/ no \quad yes/ no\]
11. Locks and Monitors – Look at the following *slightly-modified* code from the previous question (look at lines 4, 5, 13), then answer the question that follows the code.

```java
import java.util.concurrent.locks.Lock;
import java.util.concurrent.locks.ReentrantLock;
public class Question10 extends Thread {
    private static Lock l = new ReentrantLock();
    public void a() {
        try {
            l.lock();
            System.out.println("a");
        } finally {
            l.unlock();
        }
    }
    public void b() {
        try {
            l.lock();
            System.out.println("b1");
            a();
            System.out.println("b2");
        } finally {
            l.unlock();
        }
    }
    public void run() {
        b();
        a();
    }
    public static void main(String [] args) {
        Question10 q1 = new Question10();
        Question10 q2 = new Question10();
        q1.start();
        q2.start();
    }
}
```

a. Which of the following outputs are possible? Circle yes or no below the output.

(0.25%+0.25%+0.25%+0.25%)

<table>
<thead>
<tr>
<th>b1</th>
<th>b1</th>
<th>b1</th>
<th>b1</th>
</tr>
</thead>
<tbody>
<tr>
<td>b1</td>
<td>a</td>
<td>b1</td>
<td>a</td>
</tr>
<tr>
<td>a</td>
<td>b2</td>
<td>a</td>
<td>b1</td>
</tr>
<tr>
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<td>a</td>
<td>b2</td>
<td>b2</td>
</tr>
<tr>
<td>b2</td>
<td>b1</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>b2</td>
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<td>a</td>
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<td>b2</td>
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<tr>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>

yes / no  yes / no  yes / no  yes / no
12. Databases and SQL – Answer the following questions concerning the database below.

Here is the University table.

<table>
<thead>
<tr>
<th>universityID</th>
<th>longname</th>
<th>shortname</th>
<th>mascot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University of Southern California</td>
<td>USC</td>
<td>Trojans</td>
</tr>
<tr>
<td>2</td>
<td>University of California Los Angeles</td>
<td>UCLA</td>
<td>Bruins</td>
</tr>
<tr>
<td>3</td>
<td>Stanford</td>
<td>Stanford</td>
<td>Trees</td>
</tr>
<tr>
<td>4</td>
<td>University of California Berkeley</td>
<td>Cal</td>
<td>Bears</td>
</tr>
</tbody>
</table>

Here is the Department table.

<table>
<thead>
<tr>
<th>departmentID</th>
<th>deptname</th>
<th>deptabbr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer Science</td>
<td>CSCI</td>
</tr>
<tr>
<td>2</td>
<td>Law</td>
<td>LAW</td>
</tr>
<tr>
<td>3</td>
<td>Medicine</td>
<td>MED</td>
</tr>
</tbody>
</table>

Here is the Ranking table.

<table>
<thead>
<tr>
<th>rankingID</th>
<th>universityID</th>
<th>departmentID</th>
<th>rankNum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
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<td>1</td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
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<tr>
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<tr>
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<td>2</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

a. Write the SQL code to create the Ranking table. (0.5%)

```sql
CREATE TABLE Ranking ( 
    rankingID INT(11) PRIMARY KEY AUTO_INCREMENT, 
    universityID INT(11) NOT NULL, 
    departmentID INT(11) NOT NULL, 
    rankNum INT(2) NOT NULL, 
    FOREIGN KEY (universityID) REFERENCES University(universityID), 
    FOREIGN KEY (departmentID) REFERENCES Department(departmentID) 
);
```

b. Write the SQL code to get the departments that have been ranked #1 at each university. You will not return the rank. In other words, the following table should be returned by the SELECT statement. (0.75%)

```sql
SELECT shortname, deptabbr 
FROM University u, Department d, Ranking r 
WHERE u.universityID=r.universityID 
AND d.departmentID=r.departmentID 
AND r.rankNum=1;
```
c. Draw the table that is returned from the following query. (0.75%) 

```
SELECT shortname, mascot, deptname
    FROM University, Department
    ORDER BY shortname ASC, deptname DESC;
```

<table>
<thead>
<tr>
<th>shortname</th>
<th>mascot</th>
<th>deptname</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cal</td>
<td>Bears</td>
<td>Medicine</td>
</tr>
<tr>
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<td>Bears</td>
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<td>Trojans</td>
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</tr>
</tbody>
</table>
Extra Credit Questions

Extra credit is applied after the curve so does not affect other students.

Extra Credit (0.25%) – In 201, we are supposed to begin working on writing larger programs, which is why you had at least two weeks for any assignment. However, sometimes larger assignments are daunting at first, so I create multiple assignments that build on each other (such as assignments 2 and 3). Would you prefer longer assignments with more time to complete them (like assignment 4/5) or shorter assignments that build on each other (like assignments 2 and 3)? Explain.

Circle one

<table>
<thead>
<tr>
<th>Shorter assignments that build on each other</th>
<th>Longer assignments with more time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explain

Extra Credit (0.25%) – If you could go back and evaluate your 103 and 104 professors/classes again, would you give a different evaluation? Specifically, on the following two questions, would you give a higher evaluation, lower evaluation, or the same that you did?

Overall, how would you rate this instructor?

Circle one

<table>
<thead>
<tr>
<th>I would give a higher evaluation than I did.</th>
<th>I would give the same evaluation that I did.</th>
<th>I would give a lower evaluation than I did.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Explain

Overall, how would you rate this course?

Circle one

<table>
<thead>
<tr>
<th>I would give a higher evaluation than I did.</th>
<th>I would give the same evaluation that I did.</th>
<th>I would give a lower evaluation than I did.</th>
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</thead>
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Explain