1. What are the differences among Java applications, applets, and servlets? (20%)

2. Based on J2EE specifications, what are entity bean and EJB? (20%)

3. Draw execution result of the following Java application. (30%)

```java
import java.awt.Graphics;
import javax.swing.JApplet;
public class WhileCounter extends JApplet {
    public void paint( Graphics g )
    {
        super.paint( g );
        int counter = 1;
        while ( counter <= 10 ) {
            g.drawLine( 10, 10, 250, counter * 10 );
            ++counter;
        }
    }
}
```

4. Write a Java application whose execution result is shown as follows. (30%)
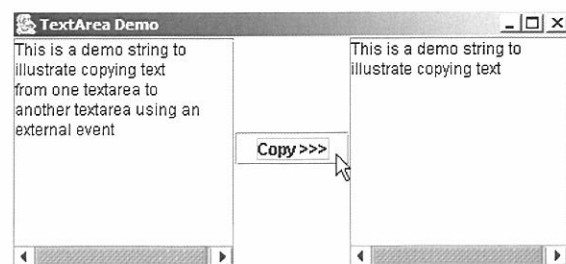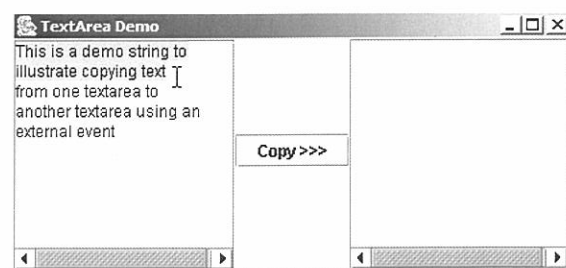
1. （15%）Show the result of inserting the followings into an initially empty binary search tree: 30, 35, 22, 89, 11, 71, 62, 88, 99.

2. （15%）Given two positive integers i and j, the greatest common divisor (gcd) of i and j, gcd (i,j) is the largest integer k such that (i%k=0) and (j%k=0). Develop a recursive method that returns the gcd of i and j.

3. (15%) Insert 2 , 4 , 1 , 5 , 3 , 9 , 6 to an initially empty AVL tree. Show the result.

4. (15%) The array "1 3 4 5 8 9 6" denotes a "min-heap".
    (a) Draw a sketch to show the heap.
    (b) Draw a sketch to show the heap after inserting 2 to it.

5. (10%) Insert 5, 2, 7, 0, 3, 4, 6, 1, 8, 9 to an initially empty 2-3 tree. Show the result.

6. （10%）What is the Big-Oh estimate of the below:
```
for (int j = 0; j < n; j++)
    for (int k = 0; k < n; k++)
        gui.println (j + " " + k);
```

7. (5%) (a)Under what circumstances should an application chooses to use ArrayList?
(5%) (b)Under what circumstances should an application chooses to use LinkedList?

Note that ArrayList and LinkedList are two reusable classes in the Java collection framework. ArrayList uses array to implement list, while LinkedList uses linked structure to do it.

8. (10%) Show the Big-Oh time estimates of insertion or deletion in ArrayList and LinkedList, respectively. Explain your estimates.

1. Simplify the Boolean function $F(W, X, Y, Z) = \Sigma m$ (0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14). (10%)

2. Determine the prime implicants and essential prime implicants of the following Boolean function: $F = w'y + xyz + wy'z' + wz$. (10%)

3. A logic circuit implements the following Boolean function: $F = A'C + AC'D'$. It is found that the circuit combination $A = C = 1$ can never occur. Find a simpler expression for F using the proper don't-care conditions. (10%)

4. Design a 4-to-16 decoder, using 2-to-4 decoders. (10%)

5. For arbitrary Boolean functions, compare the cost and delay of their implementations with: a PROM, a PLA, and a random logic. (15%)

6. Implement JK flip-flops using only AND, OR, and inverter gates, and D flip-flop. (10%)

7. Construct a 4-bit asynchronous counter using T flip-flops. (15%)

8. Design a counter that counts in the following sequence 0, 1, 2, 4, 8, 0, ... using D flip-flops. (20%)

1. (30%) $\forall a,b,c,d \in N$, if a and b are relative prime and $a > b$, then prove:

$$\gcd(a^m - b^m, a^n - b^n) = a^{\gcd(m,n)} - b^{\gcd(m,n)}, 0 \le m < n.$$

(hint: Euclidean Algorithm)

2. (15%) a) Suppose $|A| = 5, |B| = 10$. Find the number of functions $f : A \to B$.

   b) Suppose $|A| = 5, |B| = 10$. Find the number of 1 to 1 functions $f : A \to B$.

   c) Suppose $|A| = 10, |B| = 5$. Find the number of 1 to 1 functions $f : A \to B$..

3. (20%)

   a) Find the number of subsets of $S = \{1,2,3,\ldots,10\}$ that contain the number 6 and 7.

   b) Find the number of subsets of $S = \{1,2,3,\ldots,10\}$ that contain no odd numbers.

   c) Find the number of subsets of $S = \{1,2,3,\ldots,10\}$ that contain exactly 4 numbers and one of which is 2.

   d) Find the number of subsets of $S = \{1,2,3,\ldots,10\}$ that contain exactly 5 numbers and the sum of which is even.

4. (20%) Use the definition of big-oh to prove that
$(1 \times 2) + (2 \times 3) + (3 \times 4) + \ldots + ((n-1) \times n)$ is $O(n^3)$

5. (15%) Solve the recurrence relation
$a_n = 5a_{n-1} - 4a_{n-2}$, $a_0 = 0$, $a_1 = 1$.