Just take a minute to skim the paper read all the questions before attempting, and first try to answer those questions/parts about which you feel most confident. The questions are roughly arranged in order of increasing difficulty. Do NOT spend too much time on one question. Pace yourself @ 100 points/75 minutes. You may consult:
1. Lecture Slides (preferably 4/page).
2. 1 sheet (front/back) of printed material... No restriction on font.
3. 1 sheet of Java syntax & any amount of handwritten notes (you can't have any code segments allowed)
4. Any code that was provided in hangman or clever hangman (but not your own code).

You may not use any computers, calculators, cell phones, minions, or other lifeforms. When writing code you do not need to worry about specifying the proper import statements. If you don’t know the exact syntax, do the best you can to get partial credit. The programming logic is more important than minor syntax. Assume that all libraries and packages we’ve discussed are imported in any code you write. You may write any helper methods you would like in solving the problems. If you don’t have enough time, assume the helper method and give us the main logic. Master the art of partial credit!

1. (5 points) I still haven’t found what I am looking for!
   Consider the binary tree below.
   a. Show the path that you will follow if you search for 7 on the figure on the left.
   b. Show the result of inserting 2 and 12 in the figure on the right.

2. (12 points) Equate this!
   Write the following equations as Java assignments. For example, \( x = (a^2+2ab+b^2) \) can be written as \( x = a*a + 2*a*b + b*b \). Not that you can write \( m_1 \) as \( m1 \), etc. and assume that these are all type double and that you have \( \text{Math.sqrt(number)} \) and \( \text{Math.pow(base,power)} \) available. (2 points for each line)
   a. \( E = mc^2 \)
   b. \( w = e^{xy} \)
   c. \( F = \frac{G m_1 m_2}{d^2} \)
   d. 2 versions of this equation \( x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \)
      with + \( \frac{\sqrt{b^2 - 4ac} \quad \text{with} \quad - \sqrt{b^2 - 4ac}}{2a} \)
   e. \( T_a = \frac{T_n}{\sqrt{1 - \frac{v^2}{c^2}}} \)
3. **(8 points) Can you handle the truth?**

Fill out the following table with boolean values of true/false.

| a   | b   | !a && b | (a || (a && b)) | (a || b) && (!a || !b) | !(a && b) || (a && b) |
|-----|-----|---------|-----------------|------------------------|-----------------------|
| true| true| false   | true            | true                   | true                  |
| true| false| true    | true            | false                  | true                  |
| false| true| false   | false           | true                   | true                  |
| false| false| false   | false           | false                  | true                  |

4. **(15 point) Big Oh time**

Give the running time of the following code segments as in terms of big-Oh if n. Also, give values of a, b, and x when they are invoked with \( n = 50 \). Assume that initially a, b, and x are defined as follows before every code segments.

```java
int a = 100;
int b = 10;
double x = 16.0;
```

// Note: Even though the values are calculated with \( n = 50 \) (a constant), please express your running time as function of n, i.e. \( O(f(n)) \), considering that it can be set to any value.

a. **(2 pts) Code segment 0**

```java
b = a;
if (a > 0) {
a = b;
}
```

Running time = \( O(1) \) b = 1000

b. **(5 pts) Code segment 1**

```java
for (int i = 0; i < n/5; i=i+2) {
x = x/2;
a = a*2;
}
```

Running time = \( O(n) \) a = 3200 b = 15 x = 0.5

c. **(5 pts) Code segment 2**

```java
for (int i = 0; i < n; I = i+10) {
for (int j = 0; j < i; j++) {
x = ++aa + b++;
}
}
```

Running time = \( O(n^2) \) a = 105 b = 15 x = 119.0

d. **(3 pts) Code segment 3**

```java
for (int i = 0; i < n/10; i++) {
for (int j = 0; j < n; j=j*2) {
a = b++;
}
}
```

Running time = \( O(n \log n) \)

e. **(3 pts) In the code segments above, circle the a, b, c, or d based on the rank order the running times of the code segments.**

i. Fastest a b c d
ii. 2nd fastest a b c d
iii. 3rd fastest a b c d
iv. Slowest a b c d
5. **(14 points) My Favorite Color is Blue**

As you know, there is no better color than Duke Blue (RGB code 0, 0, 156). The rest of the colors are ranked by their luminance with black (0, 0, 0) being the second best and white (255, 255, 255) being the worst. In case of a tie, it doesn’t matter which one you select. But there is one exception - the Duke Blue is the best color of all. You are given an ArrayList of Color, each element of which contains a single Color return the best Color in the list. You may assume that you can call a static method `double Luminance.getLum(Color c)` that returns the luminance of any Color c.

a. (2 pts) Name two checks should you have in place to make sure that this method protects itself?
   - 
   - 

b. (10 pts) Please fill in the code to find the best color below. You may assume that the code for the checks above is going to be done correctly by someone else and you have access to ArrayList methods (size(), get(int index), etc.) and object/Color methods (color.equals(Color), etc.).

```java
import java.awt.Color;
public class DukeBlue {
    public static Color DUKEBLUE = new Color(0, 0, 156);
    public Color bestColor(ArrayList<Color> colors) {
        // assume code for 2 checks you listed above
    }
}
```
c. (2 pts) Should we use TreeMap rather than HashMap in the previous question? Give one reason why.

6. (12 points) I am # 2!
I have spent my life shooting for #2 and it is time for me to accept that and start looking for others like me. Since you are a better coder than I am, please help me write a method that takes as input an array of integers and returns the second highest integer from the list.

a. (2 pts) Name two checks should you have in place to make sure that this method protects itself?
- 
- 

b. (10 pts) Please fill in the code to find the second best item below. You may assume that the code for the checks above is going to be done correctly by someone else.

```java
public class IamNumber2 {
    public integer secondBest(int[] inputs) {
        // assume code for 2 checks you listed above
    }
}
```
7. **(12 points) What’s my GPA?**

You are asked to write a method to compute GPA for ACES. The input is:
- An array of grades that contain the letter and optional +/-
- An array of doubles that contain the corresponding credits (in the same order)

The output is a double for computed GPA. You may assume that the map gives you correct numeric equivalent of the grades (4.0, 3.7, ...).

a. (2 pts) Name two checks should you have in place to make sure that this method protects itself?
- 
- 

b. (10 pts) Please fill in the code to calculate the GPA below. You may assume that the code for the checks above is going to be done correctly by someone else.

Brendan to add Map concept

```java
public class GPACalculator {
    public double myGPA(ArrayList<String> grades, double[] credits) {
        // assume code for 2 checks you listed above
```
8. (22 points) Reverse this!

I want to take a linked list and reverse its order.

a. (10 pts) By focusing on the problem state the lower bound and give concise reasoning behind your answer. (A formal proof is not needed as long as you convey solid reasoning).

b. (2 pts) Part c requires you to reverse the list using Stacks or Queues. Name another way along with one advantages over using Stacks or Queues (or name two other ways). You don’t have to code these alternatives.

c. (10 pts) Please fill in the code on the next page to reverse the linked list using either Stacks or Queues. Assume that you have Stack and Queue classes available with the following interfaces:

```java
public class StackOfStrings()
    StackOfStrings() { // create an empty stack
    void push(String item) { // insert a new string onto stack
    String pop() { // remove & return the top
    boolean isEmpty() { // is the stack empty?
    int size() { // number of strings on the stack

public class QueueOfStrings()
    QueueOfStrings() { // create an empty queue
    void enqueue(String s) { // insert a new string onto stack
    String dequeue() { // remove and return the head
    boolean isEmpty() { // is the queue empty?
    int size() { // # of strings in the queue

public class LinkedLister {
    public Node reverse(Node inList) {
```

```
// assume node
// class below
public class Node {
    String value;
    Node next;
}

// this pattern may help
public int size(Node list){
    int count = 0;
    while (list != null) {
        count++;
        list = list.next;
    }
    return count;
}