7. What are the final values of $i$, $j$, $k$, and $*p$ after executing the following C program segment?

```c
int i = 10, j = 20, k = 30;
int *p;
p = &k;
*p = *p + 3;
p = &j;
*p = 0;
p = &i;
```

8. In Haskell, a symbol `mystery` has the following type:

```haskell
mystery :: t -> t -> t -> [t]
```

Which of the following definitions of `mystery` is compatible with this type?

(a) `let mystery x y z = [x,y,z]`
(b) `let mystery x y = [] ++ x ++ y`
(c) `let mystery x y z = x * y * z`
(d) `let mystery x y = (x,y)`

9. True or False:

(a) The Haskell “let” command is used to assign a value to a variable.
(b) Java uses dynamic scoping for all variables
(c) One of the steps in compiling is the generation of intermediate code
(d) In Haskell, lists may contain only data of a single type

10. In Java, an array is declared as “`int x[] = new int[20][10];`”. Assuming that element `x[0][0]` is stored at memory address 1000, at what address is `x[2][1]` located?

11. In Haskell, suppose we have two functions defined as follows:

```haskell
Prelude> let f x y z = 2*x + y - z
Prelude> let g = f 2 3
```

What is the value of `g 3`?
```cpp
#include <iostream>
#include <string>
using namespace std;

class Parent {
public:
    string msg() {
        return "Parent";
    }
};

class Child: public Parent {
public:
    string msg() {
        return "Child";
    }
};

int main() {
    Child c;
    Parent p = c;
    cout << "Parent: " + p.msg();
    cout << " , Child: " + c.msg() << endl;
}
```

```java
import java.lang.String;

public class Parent {
    public String msg() {
        return "Parent";
    }
}

class Child extends Parent {
    public String msg() {
        return "Child";
    }
}

class Final {
    public static void main(String[] args) {
        Child x = new Child();
        Parent y = x;
        System.out.print("Parent: " + x.msg());
        System.out.println(" , Child: " + y.msg());
    }
}
```

Figure 1: See questions 12, 13, and 14
Figure 1 shows two programs, one written in C++, the other in Java. In both programs, a \texttt{Parent} class has a public method named \texttt{msg}. A \texttt{Child} class overrides the method \texttt{msg} with a new one. In the \texttt{main} function of both programs, a \texttt{Child} object named \texttt{x} is created and assigned to a \texttt{Parent} object named \texttt{y}.

12. What is the output of the C++ program?

(a) \texttt{Parent: Parent, Child: Parent}
(b) \texttt{Parent: Parent, Child: Child}
(c) \texttt{Parent: Child, Child: Parent}
(d) \texttt{Parent: Child, Child: Child}

13. What is the output of the Java program?

(a) \texttt{Parent: Parent, Child: Parent}
(b) \texttt{Parent: Parent, Child: Child}
(c) \texttt{Parent: Child, Child: Parent}
(d) \texttt{Parent: Child, Child: Child}

14. What is the default method-binding mode for C++? What is the default method-binding mode for Java?

15. Refer to the JavaScript programs in Figure 2.

\begin{verbatim}
function f(x) {
    var x;
    x = 20;
}
console.log(x);

f(1);
\end{verbatim}

(a) \begin{verbatim}
"use strict";
function f(x) {
    let x;
    x = 20;
}
console.log(x);

f(1);
\end{verbatim} (b)

Figure 2: See problem 15

What is printed by program (a)? What is printed by program (b)?

16. If “op” is the name of a binary operator in a programming language, what does it mean to say that \texttt{op} is right-associative? In other words, what is the definition of a “right-associative operator”?

17. Given the following Prolog database:
prereq(cs111,cs112).
prereq(cs112,cs210).
prereq(cs112,cs220).
prereq(cs220,cs280).
prereq(cs210,cs280).
needs(X,Y) :- prereq(X,Y).
needs(X,Y) :- prereq(X,Z),needs(Z,Y).

The prereq facts describe prerequisites for courses as described in the Allegheny Bulletin, e.g., “cs111 is a prerequisite for cs112.” The needs rules describe all courses a student needs to take (not just the immediate prerequisites, but the prerequisites of the prerequisites, etc.).

(a) What query would we use to find out all the courses a student needs to take in order to take cs280?

(b) What values of variable X satisfy the query “needs(cs112,X).”?

18. Which parameter evaluation order—applicative, normal, or lazy—requires one-time evaluation of parameter expressions prior to passing them into the function?

19. In Python, suppose function f is defined as follows:

```python
def f(x):
    return x*x
```

What is the value of the expression map(f,[2,3,4,5])?

20. In Common Lisp, what is the value of the expression (cons '3 '(3 3 3))?

21. What is the difference between C's union data type and C's struct data type (recall that the struct is an example of a record data type)?

22. List the steps in compiling a program.

23. Explain the difference between the static pointer and the dynamic pointer in an activation record stack.

24. In the following Java method, give examples of static allocation, stack allocation, and heap allocation (use the line numbers):

```java
public int f() {
    Stack<String> s = new Stack<String>();
    String i;
    int j;
    i = "This is a string";
    j = 1192;
    }
```