The exam is open book and open notes.

The exam will be comprehensive and similar in style to the previous hour exam. The exam will be in three sections. Section 1 will consist of short answer questions. Section 2 will contain programs which you will be asked explain. In Section 3 you will be asked to write programs.

At least one question will involve the implementation of a program using classes. Other likely topics for programs include multidimensional arrays and strings.
Sample problems for review

1. Short answer questions will cover all topics. Some example short answer questions are given below:
   a) If \( m = 24 \) and \( n = 7 \) what is the value of \(++m - n--\) ______
   b) if \( m = 6 \) and \( n = 19 \) is the following true or false: \((m ==6) || !(m+n<20)\) _____
   c) How many lines will the following program print? _____
      ```
      int n = 7;
      {cout << n << endl;
       n++;
      }
      ```
   d) Distinguish between a public and private class member.
   e) What is the purpose of a constructor in a class declaration.
   f) What is the scope resolution operator and what is it used for?
   g) Explain function overloading.
   h) How can you access the memory address of an integer?

2. Show what is printed by the following program and construct a memory map for the variables.
   ```
   #include <iostream.h>
   void Fun(int, int);
   void Fun(int);
   main()
   {int a = 7, b = 5;
   Fun(a);
   cout << a << b << endl;
   Fun(a, b);
   return 0;
   }
   //
   void Fun(int x, int y)
   {cout << x + y << endl;
   Fun(x);
   }
   //
   void Fun(int z)
   {cout << z*z << endl;
   }
   ```

3. a) Write a function which will return the first value of \( y \) that exceeds 100 in the equation given by \( y = (x + x^3) / (3x - 1) \). Your function should evaluate the equation for \( y \) starting at \( x = 1 \) and continuing in increments of 0.01. A sample calling statement for your function is given by
   ```
   double z;
   z = YFunction;
   ```
4. Write a program which inputs a single integer, x from the user. For $0 \leq x \leq 90$ call function F1 below and print its results. For $90 < x \leq 180$ call function G1 below and print its results. Otherwise, print the word "Illegal".

```c
float F1(int x)
{
    float y;
    y = x*3.14159/180;
    return cos(x);
}

//
float G1(int x)
{
    float y;
    y = x*3.14159/180;
    return -cos(x);
}
```

5. The program below uses a \texttt{switch} structure. Answer the following questions:
   A) What does the program print if the number entered is a 9? __________
   B) What does the program print if the number entered is a 0? __________
   C) What does the program print if the number entered is a 1? __________

```c
#include<stdio.h>
main()
{
    int In, j = 2;
    cout << "Enter an integer...";
    cin >> In;
    switch (In)
    {
      case 0:
        j = 9;
        cout << (j + In)
      case 1:
        cout << In;
        break;
      default:
        cout << "Error";
        break;
    }
    return 0;
}
```

6. Write a program to find the sum of the rows of the matrix below:

```
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16
```

Print the sums in four lines as "Sum of row 1 = XXX"
7. Answer the questions below about the program which operates on the 4 x 5 array.

```cpp
#include <iostream.h>
main()
{int M[4][5];
 int i, j;
 for(i=0;i<4;i++)
 {for(j=0;j<5;j++)
  {M[i][j] = i;
   M[0][j] = 0;
  }
 }
 return 0;
}
```

a) What values are stored in column 0? (List all) ___________________

b) What values are stored in row 1? (List all) _______________

c) How many values are stored in the array?_____________

d) What value is stored in the bottom right corner of the array?______________

8. Given below is a C++ program that declares a class variable called "Course".

A) Add the print routine to the program (after the main code). This routine should print the value of all private variables.

B) Add a destructor function to the class which prints the phrase "Course destroyed." when activated.

C) In the main program add appropriate lines of code to do the following:
   1) Declare two variables a and b to be of type Course.
   2) For the variable a, set the department to "Engr", the number to "123", the hours to 3, and the load to 3.
   3) Copy the a variable into the b variable.
   4) Print the value of the b variable using the function you wrote for part A.

```cpp
#include <iostream.h>
class Course
{private:
   char dept[20];
   char num[20];
   int Hrs;
   int Ld;

public:
   void Print(void);
};

int main()
{

 return 0;
}
```
9. Write a C++ program to input 3 integers and print them out in order (from highest to lowest) using the if statement to determine the order.

10. Write a C++ program that reads in a grade A, B, C, D, or F and prints out the words "excellent", "good", "fair", "poor", and "failure". Use a switch statement.

11. Write a program to calculate values of y from the equation \( y = 3x^3 - 4x^2 + 23 \). Your program should start with \( x = 0 \) and increment \( x \) in steps of .1 until the value of \( y \) exceeds 100. Print no value of \( y \) in excess of 100. Use a function to evaluate \( y \).

12. Write a program that reverses the digits of a given positive integer.

13. A Babylonian algorithm for finding the square root of a number, \( x \), iteratively replaces \( x \) by the average of \( x \) and \( x/2 \). That is, to find the square root of \( x \), you set \( x = (x + x/2)/2 \). You continue doing this until \( x \) is equal to the square root of \( x \) within some stated tolerance. Write a program to use the Babylonian algorithm to find the square root of 2 within a tolerance of 0.0001.

14. Write a function to swap two integers.

15. Write a function that returns the kth digits of the integer \( n \). A typical calling statement might be
   
   \[
   m = \text{digit}(n, k);
   \]

   If \( n = 1234567 \) and \( k = 2 \), your function would return 6.

16. Write a program that fills an integer array with 100 random numbers (from 1 to 12) and prints their sum, average, maximum, and minimum.

17. Write a program to read in a line of text up to 80 characters in length and removes the letter "a" from the line.

18. Write a program to accept a single line of text up to 80 characters in length and determines if that line is a palindrome.

19. Explain the difference between a public and a private data member of a class.

20. When is a constructor executed.

21. What is wrong with the following code.

```cpp
main()
{
    const double pi;
    int n;
    pi = 3.14159256358979;
    n = 22;
}
```
22. For the program below which creates a class called exmp, do the following:
A) Add a constructor to the class such that the variables a and b can both be initialized.

B) Add a public function to the class that will add one to variables a and b.

```cpp
#include <iostream.h>

class exmp {
private:
    int a;
public:
    int b;
    int AddPrivate(int c);
};

int main()
{
    int i = 5;
    exmp X;
    X.b = 7;
    cout << X.b + i << endl;
    cout << X.AddPrivate(i) << endl;
    return 0;
}

int exmp::AddPrivate(int c)
{
    a = 5;
    return (c + a);
}
```
23. The following program creates a class called complex. The statements in *italics* have been added to create a public function prototype in the class definition. Write the code for the function. The function should add two complex types. A typical call statement has been added to the main program.

```cpp
#include <iostream.h>
class complex
{
    float real;
    float imag;

public:
    void prt();
    void set(float a, float b);
    void multiply(complex A, complex B, complex &C);
    complex add(complex, complex);
};

main()
{
    float c, d;
    complex A, B, C, D;
    cin >> "Enter two number..." << endl;
    cin >> c >> d;
    A.set(c, d);
    cout << endl << "Enter two more numbers..." << endl;
    cin >> c >> d;
    B.set(c, d);
    C.multiply(A, B, C);
    C.prt();
    D = add(A, B); //Added line to excercise the Add function.
    return 0;
}

//
void complex::prt()
{
    cout << real << " +j " << imag << endl;
}

//
void complex::set(float a, float b)
{
    real = a;
    imag = b;
}

//
void complex::multiply(complex A, complex B, complex &C)
{
    C.real = A.real*B.real - A.imag*B.imag;
    C.imag = A.real*B.imag + A.imag*B.real;
}
```
24. Given below is a definition for a class object called *rectangle*. Complete the following.

A) Write a constructor definition for rectangle. The constructor should initialize all private variables to zero. Note that the prototype is already given.

B) Write the Set function for rectangle which determines the relative size of the two arguments and sets longSide equal to the longest and shortSide equal to the shortest.

C) In a main program declare two objects called r1 and r2 to be of type rectangle.

D) In a main program input two variables and use the Set function to set the private variables of r1.

```cpp
class rectangle
{
public:
    rectangle();
    double Area(void);
    double Perimeter(void);
    void Set(double side1, double side2);
    void Print(void);
private:
    double longSide;
    double shortSide;
};

void main()
{
    // Put the constructor definition here

    // Put the Set function here
}
```