

DUBLIN CITY UNIVERSITY

SEMESTER TWO EXAMINATIONS 2005

MODULE: CA146
(Title & Code) Introduction to Programming

COURSE: BSc. In Applied Physics
BSc. In Physics with Astronomy
Science International Programme

YEAR: 1

EXAMINERS: Dr. Paul Gibson
Dr. Martin Crane Ext: 8974

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Please answer any 4 questions: All questions carry equal marks

*Requirements for this paper
Please tick (X) as appropriate*

- | | |
|--------------------------|------------------------------|
| <input type="checkbox"/> | <i>Log Table</i> |
| <input type="checkbox"/> | <i>Graph Paper</i> |
| <input type="checkbox"/> | <i>Attached Answer Sheet</i> |
| <input type="checkbox"/> | <i>Statistical Tables</i> |
| <input type="checkbox"/> | <i>Floppy Disk</i> |
| <input type="checkbox"/> | <i>Actuarial Tables</i> |

**THE USE OF PROGRAMMABLE OR TEXT STORING CALCULATORS
IS EXPRESSLY FORBIDDEN**

**PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED
TO DO SO**

Answer any FOUR questions. All questions are worth 25 marks.

Q1

The Fibonacci numbers are a sequence of numbers in which each successive number is the sum of the previous two numbers i.e.

$$X_n = X_{n-1} + X_{n-2}$$

If the first two Fibonacci numbers are 0 & 1 (i.e. $X_1=0$ and $X_2=1$), write a program which prints out the first 20 Fibonacci numbers.

Q2

Write a program to find the roots of a quadratic equation. All quadratic equations have the form

$$ax^2 + bx + c$$

where a , b and c are constants. The roots of the equation are given by

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Write a program to calculate the roots and print them out. Use a `cin` statement to read in the values of a , b and c . Use an `if` statement to prevent you taking the square root of a negative number.

Q3

Write a program to prompt the user to input a number from the keyboard. The program should then test whether the number is a perfect square (such as 1, 4, 9, 16...) or not.

Q4

Write a **function** to calculate the exponential of a number x given the following formula for $\exp(x)$:

$$\text{Exp}(x) = 1 + x + x^2/2 + x^3/6 + x^4/24$$

Write a program in C++ which prompts the user for a number from the keyboard and returns the exponential of that number. It should continue to take in numbers until 99 is input at which point it should exit.

Q5

Write a program that reads in a 3x3 integer matrix A from the screen, stores it in a 2D array and decides whether it is symmetric. A matrix is symmetric if each member $A_{ij} = A_{ji}$: or, in other words, if the matrix is reflected about the leading diagonal it remains unchanged.

Q6

Write a function which takes three integer arguments. The function should find the maximum of the three arguments and return it to the main program. Write a program which calls this function.

DUBLIN CITY UNIVERSITY

SEMESTER TWO EXAMINATIONS 2006

MODULE: Introduction to Programming
(Title & Code) CA146

COURSE: B.Sc. in Applied Physics (AP)
B.Sc. in Physics with Astronomy (PHA)
B.Sc. in Science International (SCI)
Study Abroad (Science & Health) (SHSA)

YEAR: 1

EXAMINERS: Dr. P. Gibson
Dr. W.G. Tuohey Ext: 8728

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Please answer any 4 questions.
All questions carry equal marks

Requirements for this paper
Please tick (X) as appropriate

<input type="checkbox"/>	<i>Log Table</i>
<input type="checkbox"/>	<i>Graph Paper</i>
<input type="checkbox"/>	<i>Attached Answer Sheet</i>
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Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

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Question 1

Suppose a person invests a sum of money (the “principal”) at a fixed annual rate. We are interested in the amount accrued after a number of years. Specifically, let P = principal, r = interest rate and n = number of years. Then, the amount accrued after n years is given by $A_n = P(1 + r)^n$. From this, it follows that

$$A_{n+1} = A_n(1 + r).$$

Write a program that reads in (float) values for P and r , and then prints out the amount accrued after 1 year, 2 years, 3 years, ..., 20 years.

[Total marks: 25]

Question 2

Write a program that will determine whether or not four sides (floats) that are read in could form a polygon. If the sides are labelled a, b, c, d then the following conditions must *all* be satisfied in order that a polygon can be formed:

$$a \leq b + c + d, b \leq a + c + d, c \leq a + b + d, d \leq a + b + c.$$

[Total marks: 25]

Question 3

The commission earned by a used-car salesman is determined by the following rules. If the amount of the sale is

Less than €600 there is no commission

Between €600 and €7500, the commission is 10% of the sale

Greater than €7500, the commission is €750+12% of the amount above €7500

The amount of the sale is the price of the car less the value of any trade-in. Write a program that reads the price of the car sold and the value of the trade-in and then computes the commission.

[Total marks: 25]

Question 4

Write a **function** that returns the value of $f(x)$, where

$$f(x) = \frac{3x^2 + x - 2}{x^2 - 2x + 1}$$

Then, write a program in C++ that prompts the user for a number x from the keyboard and prints the corresponding $f(x)$. The program should continue to take in numbers until 1000 is input at which point it should exit.

[Total marks: 25]

Question 5

Write a **function** that takes four integer arguments. The function should find the minimum of the four arguments and return it to the main program. Write a program that reads in the four values, calls this function and prints the resulting minimum value.

[Total marks: 25]

Question 6

Write a program that first reads in a 3x2 float matrix A from the keyboard and stores it in a 2D array. Next the program should read in a second 3x2 float matrix B from the keyboard and store it in another 2D array. Finally, the program should compute and output the matrix sum of A and B.

Hint: The matrix sum is obtained by adding corresponding matrix elements.

[Total marks: 25]

DUBLIN CITY UNIVERSITY

SEMESTER TWO EXAMINATIONS 2007

MODULE: Introduction to Programming
(Title & Code) CA146

COURSE: B.Sc. in Applied Physics (AP)
B.Sc. in Physics with Astronomy (PHA)
B.Sc. in Science International (SCI)
Study Abroad (Engineering & Computing) (ECSA)

YEAR: 1

EXAMINERS: Dr. W.G. Tuohey Ext: 8728

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Please answer any 4 questions.
All questions carry equal marks

Requirements for this paper
Please tick (X) as appropriate

Log Table
Graph Paper
Attached Answer Sheet
Statistical Tables
Floppy Disk
Actuarial Tables

THE USE OF PROGRAMMABLE OR TEXT STORING CALCULATORS IS EXPRESSLY FORBIDDEN

Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

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Question 1

The trajectory of a projectile, that is its position (x_i, y_i) at time t_i , is specified as

$$x_i = v_x t_i, \quad y_i = v_y t_i - \frac{1}{2} g t_i^2$$

where v_x is the initial horizontal velocity (m/s), v_y is the initial vertical velocity (m/s), and g is acceleration due to gravity (9.8 m/s^2).

(a) Write a program to calculate and print (to screen) the values of x_i and y_i corresponding to t_i where $t_i = i \cdot dt$ for $i = 0, 1, \dots, 100$ (i.e. 101 sets of values).

Assume that $dt = 0.1$, $v_x = 10.5$ and $v_y = 51.0$. [15 marks]

(b) Extend your program for part (a) so that it finds and prints the value of t_i that corresponds to the maximum height (y_i) on the trajectory. [10 marks]

[Total marks: 25]

Question 2

Write a program that will determine whether or not three float values that are read in can represent the sides of a triangle.

If they can form a triangle, the program should determine whether the triangle is isosceles or even equilateral.

The values are to be read from the computer screen and the program should check that each of them is greater than zero. If one or more of them is less than or equal to zero, the program should prompt the user to re-enter the values.

[Total marks: 25]

Question 3

Write a program to calculate and print the sum

$$\begin{aligned} & \sqrt{(1 + 1)} + \sqrt{(1 + 2)} + \dots + \sqrt{(1 + 10)} + \\ & \sqrt{(2 + 1)} + \sqrt{(2 + 2)} + \dots + \sqrt{(2 + 10)} + \\ & \dots \\ & \sqrt{(10 + 1)} + \sqrt{(10 + 2)} + \dots + \sqrt{(10 + 10)} \end{aligned}$$

that is $\sum_{i=1}^{10} \sum_{j=1}^{10} \sqrt{(i + j)}$

Note: Your program will need to contain "#include <math.h>" in order to make use of the sqrt() function.

[Total marks: 25]

Question 4

(a) The following program is given:

```
#include <iostream.h>
const int ARR_MAX=10;
int main(void)
{
    int i,j,imin,n;
    float min,arr[ARR_MAX]={6.0,8.0,2.4,1.6};
    n=4;
    cout<<"Initial array elements: "<<endl;
    for(i=0;i<n;i++)cout<<arr[i]<<" ";
    cout<<endl;
//
    for(i=0;i<n;i++)
    {
        min=arr[i];imin=i;
        for(j=i+1;j<n;j++)
            if(min>arr[j]){min=arr[j];imin=j;}
        arr[imin]=arr[i];
        arr[i]=min;
    }
//
    cout<<"Processed array elements: "<<endl;
    for(i=0;i<n;i++)cout<<arr[i]<<" ";
    cout<<endl;
return 0;
}
```

Explain what this program does. In particular, write out all the output produced by the program.

[8 marks]

(b) The values of eccentricity for the solar system planets are

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
0.206	0.007	0.017	0.093	0.048	0.056	0.047	0.009

Modify the program given in part (a) so that it computes and prints the median of these eccentricities.

[17 marks]

[Total marks: 25]

Question 5

(a) Write a **function** that returns the value of $f(i, j)$, where

$f(i, j) = 1.0/(i + j + 1)$ where i and j are integers.

[8 marks]

(b) Write a main program which makes use of $f(i, j)$, from part (a), to calculate and print the elements of the 2-dimensional array A whose elements are defined as $A_{i,j} = f(i, j)$, that is

$$A = \begin{pmatrix} 1/1 & 1/(1+1) & 1/(2+1) & \dots \\ 1/(1+1) & 1/(2+1) & 1/(3+1) & \dots \\ 1/(2+1) & 1/(3+1) & 1/(4+1) & \dots \\ \dots & \dots & \dots & \dots \end{pmatrix}$$

Allow A to have 5 rows and 3 columns in your program.

[17 marks]

[Total marks: 25]

Question 6

Write a program that reads, successively, two 6 element float arrays, representing vectors x and y , respectively.

Then, the program should compute and output

- the vector sum $x + y$
- the dot (or scalar) product $x \cdot y$

Hint: Recall that $x \cdot y = x_0y_0 + x_1y_1 + \dots + x_ny_n$ for vectors of length $n+1$.

[Total marks: 25]

DUBLIN CITY UNIVERSITY

SEMESTER TWO REPEAT EXAMINATIONS 2008

MODULE: Introduction to Programming
(Title & Code) CA146

COURSE: B.Sc. in Applied Physics (AP)
B.Sc. in Physics with Astronomy (PHA)
BSc Physics with Biomedical Sciences (PMB)
B.Sc. in Science International (SCI)
Study Abroad (Engineering & Computing) (ECSA)

YEAR: 1

EXAMINERS: Dr. W.G. Tuohey Ext: 8728

TIME ALLOWED: 2 Hours

INSTRUCTIONS: Please answer any 4 questions.
All questions carry equal marks

Requirements for this paper
Please tick (X) as appropriate

Log Table
Graph Paper
Attached Answer Sheet
Statistical Tables
Floppy Disk
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Question 1

A set of measurements of students' heights and weights has been made. For example, a sample set of 4 measurement pairs might be

Height (inches)	Weight (pounds)
62	112
70	170
66	140
59	100

(a) Write a program which first reads the total number of measurement into an integer variable n and which then, in a loop, reads each pair of (Height, Weight) values and calculates and outputs the average height and weight.

(b) Extend your program for part (a) so that it finds and prints the weight corresponding to the greatest height.

[Total marks: 25]

Question 2

Solutions of equations of the type

$$z^3 + a_2z^2 + a_1z + a_0 = 0$$

can be classified into three cases in terms of

$$q = \frac{1}{3}a_1 - \frac{1}{9}a_2^2 \quad \text{and} \quad r = \frac{1}{6}(a_1a_2 - 3a_0) - \frac{1}{27}a_2^3$$

The three cases are

- (1) If $q^3 + r^2 > 0$ there is one real root and a pair of complex roots
- (2) If $q^3 + r^2 = 0$ there are three real roots and at least two are equal
- (3) If $q^3 + r^2 < 0$ there are three real distinct roots

Write a program that will read values for a_0 , a_1 and a_2 into "float" variables a_0 , a_1 and a_2 , respectively. Your program should then determine which of cases (1), (2) or (3) applies for these values of a_0 , a_1 and a_2 .

[Total marks: 25]

Question 3

Write a program to calculate and print the sum

$$\sqrt{-3 + 1^2 + 1} + \sqrt{-3 + 1^2 + 2} + \dots + \sqrt{-3 + 1^2 + 9} +$$

$$\sqrt{-3 + 2^2 + 1} + \sqrt{-3 + 2^2 + 2} + \dots + \sqrt{-3 + 2^2 + 9} +$$

...

$$\sqrt{-3 + 10^2 + 1} + \sqrt{-3 + 10^2 + 2} + \dots + \sqrt{-3 + 10^2 + 9}$$

that is $\sum_{i=1}^{10} \sum_{j=1}^9 \sqrt{-3 + i^2 + j}$

Note: To make use of "sqrt()" your program must contain "#include <math.h>".

[Total marks: 25]

Question 4

(a) The following program is given:

```
#include <iostream.h>
const int ARR_MAX=10;
int main(void)
{
    int i,j,imin,n;
    float min,arr[ARR_MAX]={6.0,8.0,2.4,1.6,1.4};
    n=5;
    cout<<"Initial array elements: "<<endl;
    for(i=0;i<n;i++)cout<<arr[i]<<" ";
    cout<<endl;
    for(i=0;i<n;i++)
    {
        min=arr[i];imin=i;
        for(j=i+1;j<n;j++)
            if(min>arr[j]){min=arr[j];imin=j;}
        arr[imin]=arr[i];
        arr[i]=min;
    }
    cout<<"Processed array elements: "<<endl;
    for(i=0;i<n;i++)cout<<arr[i]<<" ";
    cout<<endl;
    return 0;
}
```

Explain what this program does including writing out all its output.

[7 marks]

(b) The heights, in inches, of a group of people are

61	65	68	72	66	66	70	62	75
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Modify the program given in part (a) such that it computes and prints

the mean and median of these heights.

[18 marks]

[Total marks: 25]

Question 5

Write a **function** that takes four integer arguments. The function should find the minimum of the four arguments and return it to the main program. Write a program that reads in the four values, calls this function and prints the resulting minimum value.

[Total marks: 25]

Question 6

Write a program that first reads in a 3x2 float matrix A from the keyboard and stores it in a 2D array. Next the program should read in a second 3x2 float matrix B from the keyboard and store it in another 2D array. Finally, the program should compute and output the matrix sum of A and B.

Hint: The matrix sum is obtained by adding corresponding matrix elements.

[Total marks: 25]