

**UNIVERSITY COLLEGE DUBLIN**

THE NATIONAL UNIVERSITY OF IRELAND

An Coláiste Ollscoile, Baile Átha Cliath

Ollscoil na hÉireann, Baile Átha Cliath

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**WINTER EXAMINATIONS 1999**

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**B.Comm DEGREE EXAMINATION**

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**MIS-387 : COMPUTER PROGRAMMING TECHNIQUES**

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**Instructions for Candidates**

Answer any 5 questions

**Time : 3 hours**

**Notes for Invigilators**

Calculators are permitted

1. (a) Write a Pascal procedure that swaps the values of two real arrays. Use the procedure header

```
PROCEDURE SwapVec(VAR x,y : RArrNType; n : IndxType);
```

For example if  $x = [21, 33, 16]$ ,  $y = [65, 24, 53]$  before the swap then after the swap we have  $x = [65, 24, 53]$ ,  $y = [21, 33, 16]$ .

**Solution** : Q 1 (a)

```
PROCEDURE SwapVec(VAR x,y : RArrNType; n : IndxType);
VAR
    i      : IndxType;
    temp   : REAL;
BEGIN
    FOR i := 1 TO n DO BEGIN
        temp := x[i];
        x[i] := y[i];
        y[i] := temp;
    END; { FOR }
END. {PROC SwapVec}
```

- (b) Write a Pascal function to calculate the distance between two points  $(x_1, y_1)$  and  $(x_2, y_2)$ , where

$$Dist = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}.$$

**Solution** : Q 1 (b)

```
FUNCTION Dist(VAR x1,y1,x2,y2:REAL):REAL;
BEGIN
    Dist := Sqrt((x1-x2)*(x1-x2) + (y1-y2)*(y1-y2));
END. {FUNC Dist}
```

- (c) Given three points  $(x_1, y_1)$ ,  $(x_2, y_2)$ , and  $(x_3, y_3)$ , write a program fragment to calculate the total distance from the first to the second to the third, using the function in (b). (Assume you have this function whether you have written it or not and that all variables have been declared).

**Solution** : Q 1 (c)

```
Dist123 := Dist(x1,y1,x2,y2)+Dist(x2,y2,x3,y3);
```

2. (a) Determine the output of the following program fragment

```

PROGRAM Sample;
VAR
  i, sum : INTEGER;
BEGIN
  sum := 0;
  FOR i := 1 TO 100 DO BEGIN
    IF (i DIV 10) = 0 THEN BEGIN
      sum := sum + 1;
    END;
    Write(sum:4);
  END; { FOR }
  Writeln;
  Writeln('sum = ', sum:4);
END. {PROG Sample}

```

**Solution** : Q 2 (a) The program starts with `sum = 0` and goes through the values `i = 1, 2, 3, ..., 100`. The variable `sum` is incremented by 1 each time `(i DIV 10) = 0`, which is true for the values `i=1, 2, ..., 9`. Hence we get the output

1 2 3 4 5 6 7 8 9 9 ... 9

and the final `Writeln` statement gives `sum = 9`

(b) Write a complete Pascal program that copies a text file and counts the number of bytes (characters) in the file copied. Make sure to prompt the user appropriately.

**Solution** : Q 2 (b) *SEE NOTES*

3. (a) Write a Pascal procedure to do *Selection Sort* on an array of  $n$  integers.

**Solution** : Q 3 (a) *SEE NOTES*

(b) Show the working of Selection Sort on the array of integers below

124, 132, 143, 33, 53, 66, 86, 87, 93, 110

**Solution** : Q 3 (b)

|            |            |            |    |    |    |    |     |     |     |     |
|------------|------------|------------|----|----|----|----|-----|-----|-----|-----|
| 124        | 132        | <b>143</b> | 33 | 53 | 66 | 86 | 87  | 93  | 110 |     |
| 124        | <b>132</b> | 110        | 33 | 53 | 66 | 86 | 87  | 93  |     | 143 |
| <b>124</b> | 93         | 110        | 33 | 53 | 66 | 86 | 87  |     | 132 | 143 |
| 87         | 93         | <b>110</b> | 33 | 53 | 66 | 86 |     | 124 | 132 | 143 |
| 87         | <b>93</b>  | 86         | 33 | 53 | 66 |    | 110 | 124 | 132 | 143 |
| <b>87</b>  | 66         | 86         | 33 | 53 |    | 93 | 110 | 124 | 132 | 143 |
| 53         | 66         | <b>86</b>  | 33 |    | 87 | 93 | 110 | 124 | 132 | 143 |
| 53         | <b>66</b>  | 33         |    | 86 | 87 | 93 | 110 | 124 | 132 | 143 |
| <b>53</b>  | 33         |            | 66 | 86 | 87 | 93 | 110 | 124 | 132 | 143 |
| 33         |            | 53         | 66 | 86 | 87 | 93 | 110 | 124 | 132 | 143 |

The maximum element at each stage is in boldface.

(c) How would you use the Selection sort procedure on an array of size  $n$  if you know that the elements after the  $k$ th are already in their correct positions.

**Solution** : Q 3 (c)

Instead of doing `SelectionSort(T, 1, n)` do `SelectionSort(T, 1, k)`

4. (a) Define the following data types
1. **FirstType** : A scalar whose values are the lower-case alphabetic characters.
  2. **SecondType** : An array whose elements are records that have 3 fields : (i) an integer, (ii) a string, and (iii) one of the values (-1, 0, +1).
  3. **ThirdType** : A record that has 3 fields, where each field is an array of 8 marks for each of 3 years.

**Solution** : Q 4 (a)

```

TYPE
  FirstType = 'a'..'z';
  SecondType = ARRAY[IndxType] OF
    RECORD
      f1 : INTEGER;
      f2 : STRING;
      f3 : -1..+1;
    END;
  ThirdType = RECORD
    Marks1 : ARRAY[1..8] OF REAL;
    Marks2 : ARRAY[1..8] OF REAL;
    Marks3 : ARRAY[1..8] OF REAL;
  END;

```

(b) Given `VAR Rec:ThirdType`, write a program fragment that calculates the average for each year and then calculates the grand average, i.e., the average of the averages.

**Solution** : Q 4 (b)

```

VAR
  i : INTEGER;
  sum1, sum2, sum3,
  Avg1, Avg2, Avg3, GrandAvg : REAL;
  Rec : ThirdType;
BEGIN
  .
  .
  .
  sum1 := 0.0; sum2 := 0.0; sum3 := 0.0;
  FOR i := 1 TO 8 DO BEGIN
    sum1 := sum1 + Rec.Marks1[i];
    sum2 := sum2 + Rec.Marks2[i];
    sum3 := sum3 + Rec.Marks3[i];
  END; {FOR}
  Avg1 := sum1/8.0;
  Avg2 := sum2/8.0;
  Avg3 := sum3/8.0;
  GrandAvg := (Avg1+Avg2+Avg3)/3.0;

```

(c) Given the function

```
Average(VAR Arr:ArrType; n:INTEGER):REAL
```

that returns the average of an array of size  $n$ , show how you would use this function to solve the problem in (b) above.

**Solution** : Q 4 (c)

```
VAR
  i : INTEGER;
  sum,
  Avg1, Avg2, Avg3, GrandAvg : REAL;
  Rec : ThirdType;
BEGIN
  .
  .
  .
  Avg1 := Average(Rec.Marks1, 8);
  Avg2 := Average(Rec.Marks2, 8);
  Avg3 := Average(Rec.Marks3, 8);
  GrandAvg := (Avg1+Avg2+Avg3)/3.0;
```

5. (a) Determine the output of the following program

```
PROGRAM Sample2;
CONST
  maxchars = 80;
VAR
  ChArr : ARRAY[1..maxchars] OF CHAR;
  i, j, n : 0..maxchars;
BEGIN
  FOR i := 1 TO maxchars DO BEGIN
    ChArr[i] := '*';
  END; { FOR i }

  FOR i := 1 TO 5 DO BEGIN
    FOR j := 1 TO i DO BEGIN
      Write(ChArr[i]);
    END; { FOR j }
    Writeln;
  END; { FOR i }

  FOR i := 5 DOWNTO 1 DO BEGIN
    FOR j := 1 TO i DO BEGIN
      Write(ChArr[i]);
    END; { FOR j }
    Writeln;
  END; { FOR i }

END. {PROG Sample2}
```

**Solution** : Q 5 (a)

The first loop fills the array **ChArr** with asterisks.

The loop **FOR j := 1 TO i** writes out **i** asterisks. This loop is nested inside the next two loops and does the same thing in each. Hence we get the following

```
FOR i := 1 TO 5 gives  i=1 *
                       i=2 **
                       i=3 ***
                       i=4 ****
                       i=5 *****
FOR i := 5 TO 1 gives i=5 *****
                       i=4 ****
                       i=3 ***
                       i=2 **
                       i=1 *
```

The first loop and the array could have been omitted if we substituted **Write('\*')** for **Write(ChArr[i])**

(b) Re-write the program above using **while** -loops instead of **for** -loops.

**Solution** : Q 5 (b)

```
PROGRAM Sample2;
CONST
  maxchars = 80;
VAR
  ChArr : ARRAY[1..maxchars] OF CHAR;
  i, j, n : 0..maxchars;
BEGIN
  i := 1;
  WHILE i <= maxchars DO BEGIN
    ChArr[i] := '*';
    Inc(i);
  END; { WHILE i }

  i := 1;
  WHILE i <= 5 DO BEGIN
    j := 1;
    WHILE j <= i DO BEGIN
      Write(ChArr[i]);
      Inc(j);
    END; { WHILE j }
    Writeln;
    Inc(i)
  END; { WHILE i }

  i := 5;
  WHILE i >= 1 DO BEGIN
    j := 1;
    WHILE j <= i DO BEGIN
      Write(ChArr[i]);
      Inc(i);
    END; { WHILE j }
    Writeln;
    Dec(i)
  END; { WHILE i }
END. {PROG Sample2}
```

6. (a) Which of the following are not valid Pascal constructions. Try to correct those that are not valid

1. A := Temp%; \*\*\*\* A := Temp;
2. CONST A := 7; \*\*\*\* CONST A = 7;
3. VAR x = INTEGER; \*\*\*\* VAR x : INTEGER;
4. Y := CON;
5. CONST z = 10;
6. a := B MOD c;
7. TYPE quote = BOOLEAN;
8. q123q123q123 + q123q123q123;
9. VAR XxY : CHAR;
10. x := x - x + x -x;
11. CONST a + b = 15; \*\*\*\* wrong -- no fix
12. a := 10; b := 5 ;

(b) Write a program fragment that calculates the following expression for a root of a quadratic :

$$r = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

**Solution** : Q 6 (b)

```
r := (-b+Sqrt(b*b-4.0*a*c))/(2.0*a)
```

(c) Write a Pascal function that calculates the *Expected Value* of a discrete random variable, defined as

$$E(x) = \sum_{i=1}^n p_i x_i,$$

where  $x_i$  is the  $i$ th value of the random variable  $x$  and  $p_i = \Pr(x = x_i)$  is its probability.

[ HINT : VECTOR-VECTOR MULTIPLICATION ]

**Solution** : Q 6 (c)

```
FUNCTION ExpValue(VAR x,p:RealArrType;n:INTEGER):REAL;
VAR
  i   : INTEGER;
  sum : REAL;
BEGIN
  sum := 0.0;
  FOR i := 1 TO n DO BEGIN
    sum := sum + p[i]*x[i];
  END; {FOR}
  ExpValue := sum;
END; {FUNC ExpValue}
```