

Ollscoil na hÉireann

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B.Comm. DEGREE EXAMINATION

MIS 387 : COMPUTER PROGRAMMING TECHNIQUES

SOLUTIONS

Prof S. McClean

Dr A. Deegan

Dr Derek R. O'Connor

Answer any 5 questions

1. (a) Determine the output of the following program :

```
PROGRAM Sample1;
VAR
  i, x : INTEGER;
BEGIN
  i := 0; x := 0;
  FOR i := 1 TO 10 DO BEGIN
    IF (i MOD 2) = 1 THEN BEGIN
      x := x + i;
    END
    ELSE BEGIN
      x := x - 1;
    END;
    Write(x : 4);
  END; { FOR }
  Writeln;
  Writeln('x = ', x:4);
END.
```

Solution.

i	i MOD 2	x
0		0
1	1	1
2	0	0
3	1	3
4	0	2
5	1	7
6	0	6
7	1	13
8	0	12
9	1	21
10	0	20

(b) In the following program translate the WHILE-loop into a FOR-loop and the FOR-loop into a WHILE-loop.

```
PROGRAM Sample2;
VAR
  i, j, x : INTEGER;
BEGIN
  i := 1; x := 0;
  WHILE i < 4 DO BEGIN
    FOR j := 1 TO i DO BEGIN
      x := x + (i + j - 1);
      Write(x : 4);
    END; { FOR }
    i := i + 1;
  END; { WHILE }
  Writeln;
  Writeln('x = ', x:4);
END.
```

Solution.

```
PROGRAM Sample2;
VAR
  i, j, x : INTEGER;
BEGIN
  x := 0;
  FOR i := 1 TO 3 DO BEGIN
    j := 1;
    WHILE j <= i DO BEGIN
      x := x + (i + j - 1);
      Write(x : 4);
      j := j + 1;
    END; { WHILE }
  END; { FOR }
  Writeln;
  Writeln('x = ', x:4);
END.
```

(c) What is the output of the program in (b) above?

Solution.

i	j	i+j-1	x
1	1	1	1
2	1	2	3
2	2	3	6
3	1	3	9
3	2	4	13
3	3	5	18

2. (a) The *future value* F of a sum of money P invested for n years and compounded annually at an interest rate of $i\%$ is given by the formula

$$F = P(1 + i/100)^n$$

Write a complete Pascal program that calculates a table of future values for years 1 to n . Prompt the user to input values for P , i , and n .

(Partial Credit : If you are unable to calculate F write the program assuming you are given a Pascal function `FutVal(P,i,n)` that returns the future value.)

SOLUTION

```
PROGRAM FutureValTable;
VAR
  Prin, IntRate : REAL;
  NoYears, j    : INTEGER;
FUNCTION FutVal(P,i:REAL; nyears:INTEGER):REAL;
VAR
  F : REAL;
  k : INTEGER;
BEGIN
  F := P;
  FOR k := 1 TO nyears DO BEGIN
    F := F*(1.0+i/100.0);
  END; { FOR k }
  FutVal := F;
END; { FUNC FutVal }
{----- Main Program -----}
BEGIN
  Write('Type in Principal      :');
  ReadLn(Prin);
  Write('Type in Interest Rate :');
  ReadLn(IntRate);
  Write('Type in No of Years   :')
  ReadLn(NoYears);
  FOR j := 1 TO NoYears DO BEGIN
    Writeln(j : 5, FutVal(Prin, IntRate, j));
  END; { FOR j }
END. { PROG FutureValTable }
```

(b) Write two general procedures that (1) open a text file for reading, and (2) open a text file for writing.

SOLUTION

SEE NOTES Chapter on Files

3. (a) Write a Pascal function that calculates the lowest positive value of an array $A[1..n]$ of reals. What happens if the array has no positive values?

SOLUTION

```
FUNCTION LowPos(VAR A:RArrNType; n:INTEGER):REAL;
VAR
  CurLow : REAL;
  i : INTEGER;
BEGIN
  CurLow := 0.0
  FOR i := 1 TO n DO BEGIN
    IF A[i] > 0.0 THEN BEGIN
      IF A[i] < CurLow THEN BEGIN
        CurLow := A[i];
      END;
    END;
  END; { FOR i }
  LowPos := CurLow;
END; { FUNC LowPos }
```

If the array A has no positive values then $LowPos$ returns 0.0.

- (b) Write a Pascal function that calculates the the sum of the first n natural numbers, i.e.,

$$\sum_{i=1}^n i.$$

SOLUTION

SEE NOTES

(c) Write a Pascal function that calculates the the sum of the *even* numbers between 1 and n inclusive.

SOLUTION

```

FUNCTION SumEvens(VAR A:RArrNType; n:INTEGER):REAL;
VAR
    sum : REAL;
    i   : INTEGER;
BEGIN
    sum := 0.0
    FOR i := 1 TO n DO BEGIN
        IF A[i] MOD 2 = 0 THEN BEGIN
            sum := sum + A[i];
        END;
    END; { FOR i }
    SumEvens := sum
END; { FUNC SumEvens }

```

4. (a) Define the *QuickSort* algorithm using *Lomuto's* partitioning method and show how it sorts the following array of numbers :

33,26,53,12,87,66,49,25,38,93,86,51

SOLUTION

SEE NOTES

The partitioning of the array above is

33	26	53	12	87	66	49	25	38	93	86	51
25	26	12	33	87	66	49	53	38	93	86	51
12	25	26	33	66	49	53	38	51	86	87	93
12	25	26	33	51	49	53	38	66	86	87	93
12	25	26	33	38	49	51	53	66	86	87	93
12	25	26	33	38	49	51	53	66	86	87	93

Note that the **boldface** numbers are the pivots that partition the table.

(b) Modify the QuickSort algorithm to find the *Median* of a set of n numbers.

Note : 50% are above and 50% are below the median.

SOLUTION

From the notes we have that to select the k th smallest number in an array of numbers we modify *QuickSort* as follows :

```
algorithm Select (L, U, T, k)
    p := Partition(L, U, T)
    if p = k then finished
    else if p < k then Select(p+1, U, T, k-p)
    else
        Select(L, p-1, T, k)
endalg Select
```

The median is the $n/2$ smallest number in the sorted array, i.e., the middle number. Hence we substitute $n/2$ for k above and change the name to **Median** to get :

```
algorithm Median (L, U, T, k)
    k := (L+U) DIV 2;
    p := Partition(L, U, T)
    if p = k then finished
    else if p < k then Median(p+1, U, T, k-p)
    else
        Median(L, p-1, T, k)
endalg Select
```

We do not have to write a special algorithm for *Median* once we have *Select*. We simply call *Select*(1, n , T , $n \text{ div } 2$).

5. (a) Show how you would define in Pascal the following new *types* :
1. An array of booleans whose indices range from -10 to +291.
 2. A record whose first field is an array of 5 integers, second field is an array of 10 reals, and third field is a real.
 3. An array of reals indexed from 'A' to 'Z'.
 4. An $m \times n$ array of integers.

SOLUTION

```

TYPE
  BoolArrayType = ARRAY[-10..291] OF BOOLEAN;
  RecType = RECORD
      f1 : ARRAY[1..5] OF INTEGER;
      f2 : ARRAY[1..10] OF REAL;
      f3 : REAL;
  END;
  ChArrayType = ARRAY['A'..'Z'] OF REAL;
  MatType = ARRAY[1..m,1..n] OF INTEGER;

```

- (b) List which of the following are incorrect and correct them if possible

1. VAR x : REAL ARRAY[1..n]; *WRONG : ARRAY[1..n] OF REAL*
2. -XplusY := -(X+Y); *WRONG : MXplusY := -(X+Y);*
3. Read(A[1],A[2],A[3],A[4]);
4. Write(Sqr((x+y+z)/3.0));
5. IF((a+b+c)/3.0 < 2.0) THEN etc.
6. FOR i := 11 TO 1 DO etc. *CORRECT: loop performed 0 times*
7. HalfX := .5*x; *WRONG : 0.5*x*
8. a := 1/2/3/4/5.0;

- (c) Write a single line of Pascal for the following mathematical expression

$$S = a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3}}}$$

SOLUTION

```
S := a0+1/(a1+(1/(a2+1/a3)));
```

6. (a) Write a Pascal procedure `MatAdd(A,B,n,C)` that adds two $n \times n$ matrices A and B and stores the result in C , i.e., it forms the sum

$$C_{ij} = A_{ij} + B_{ij}, \quad i, j = 1, 2, \dots, n.$$

SOLUTION SEE NOTES

- (b) Show how you can define a table of n records of names, addresses, and phone numbers in Pascal. Write a program fragment to read data into such a table.

SOLUTION

```
CONST
    n = 100;
TYPE
    RecType = RECORD
        Name   : STRING;
        Addr   : STRING;
        Phone  : STRING;
    END;
    TabRecType = ARRAY[1..n] OF RecType;
VAR
    Table : TabRecType;
    i : 0..n;
BEGIN
    FOR i := 1 TO n DO BEGIN
        Readln(Table[i].Name);
        Readln(Table[i].Addr);
        Readln(Table[i].Phone);
    END;
```

- (c) Define a new type called `RecArrType` that has the following fields :

1. `f1` is an array 1..100 of integers.
2. `f2` is an array 'a'..'t' of characters.

Write a program fragment that defines a new variable of the above type and writes out its contents.

SOLUTION

```
TYPE
    RecArrType = RECORD
        f1 : ARRAY[1..100] OF INTEGERS;
        f2 : ARRAY['a'..'t'] OF CHAR;
    END;
VAR
    A : RecArrType;
    i : INTEGER;
    ch : CHAR;
BEGIN
    FOR i := 1 TO 100 DO BEGIN
        Write(A.f1[i] : 5);
    END;
    Writeln;
    FOR ch := 'a' TO 't' DO BEGIN
        Writeln(A.f2[ch] : 5);
    END;
```