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COMPUTER SCIENCE **9608/42**

Paper 4 Written Paper **May/June 2017**

MARK SCHEME

Maximum Mark: 75

Published

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Question	Answer	Marks
1(a)		9

Label	Op code	Operand	Comment	
START:	**IN**		// INPUT character	1
	STO	**CHAR1**	// store in CHAR1	
	IN		// INPUT character	1
	STO	**CHAR2**	// store in CHAR2	
	LDD	**CHAR1**	// initialise ACC to ASCII value of CHAR1	1
LOOP:	**OUT**		//output contents of ACC	1+1
	CMP	**CHAR2**	// compare ACC with CHAR2	1
	JPE	**ENDFOR**	// if equal jump to end of FOR loop	1
	INC	**ACC**	// increment ACC	1
	JMP	**LOOP**	// jump to LOOP	1
ENDFOR:	END			
CHAR1:				
CHAR2:				

Question	Marks
1(b)	6

Label	Op code	Operand	Comment	
START:	**LDD**	**NUMBER1**		1
	XOR	MASK	// convert to one's complement	1
	INC	**ACC**	// convert to two's complement	1
	STO	**NUMBER2**		1
	END			
MASK:	**B11111111**		// show value of mask in binary here	1
NUMBER1:	B00000101		// positive integer	
NUMBER2:	**B11111011**		// show value of negative equivalent	1

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>• A pointer that doesn't point to another node/other data/address // indicates the end of the branch</td><td>1</td></tr>
<tr><td>2(b)</td><td>one mark per bullet
• node with 'Athens' linked to left pointer of Berlin (ignore null pointer)
• null pointers in left and right pointers of Athens</td><td>2</td></tr>
<tr><td>2(c)(i)</td><td>
RootPointer
0

FreePointer
7
1 mark
<table>
<tr><th></th><th>LeftPointer</th><th>Tree Data</th><th>RightPointer</th></tr>
<tr><td>[0]</td><td>2</td><td>Dublin</td><td>1</td></tr>
<tr><td>[1]</td><td>-1/∅</td><td>London</td><td>3</td></tr>
<tr><td>[2]</td><td>6</td><td>Berlin</td><td>5</td></tr>
<tr><td>[3]</td><td>4</td><td>Paris</td><td>-1/∅</td></tr>
<tr><td>[4]</td><td>-1/∅</td><td>Madrid</td><td>-1/∅</td></tr>
<tr><td>[5]</td><td>-1/∅</td><td>Copenhagen</td><td>-1/∅</td></tr>
<tr><td>[6]</td><td>-1/∅</td><td>Athens</td><td>-1/∅</td></tr>
<tr><td>[7]</td><td>8</td><td></td><td>-1/∅</td></tr>
<tr><td>[8]</td><td>9</td><td></td><td>-1/∅</td></tr>
<tr><td>[9]</td><td>-1/∅</td><td></td><td>-1/∅</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>2(c)(ii)</td><td>• –1
• It is not the number for any node.</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(d)(i)	TYPE Node **LeftPointer : INTEGER** **RightPointer : INTEGER** 1 **Data : STRING** ENDTYPE DECLARE Tree : ARRAY[0 : 9] **OF Node** 1 DECLARE FreePointer : INTEGER DECLARE RootPointer : INTEGER PROCEDURE CreateTree() DECLARE Index : INTEGER **RootPointer ← -1** 1 **FreePointer ← 0** 1 FOR Index ← 0 TO 9 // link nodes **Tree[Index].LeftPointer ← Index + 1** 1 **Tree[Index].RightPointer ← -1** 1 ENDFOR **Tree[9].LeftPointer ← -1** 1 ENDPROCEDURE	**7**

Question	Answer	Marks

2(d)(ii)	PROCEDURE AddToTree(ByVal NewDataItem : STRING)
	// if no free node report an error
	IF FreePointer = **-1** 1
	THEN
	ERROR("No free space left")
	ELSE // add new data item to first node in the free list
	NewNodePointer ← FreePointer
	Tree[NewNodePointer].Data ← NewDataItem 1
	// adjust free pointer
	FreePointer ← **Tree[FreePointer].LeftPointer** 1
	// clear left pointer
	Tree[NewNodePointer].LeftPointer ← **-1** 1
	// is tree currently empty ?
	IF **RootPointer = -1** 1
	THEN // make new node the root node
	RootPointer ← NewNodePointer 1
	ELSE // find position where new node is to be added
	Index ← RootPointer
	CALL FindInsertionPoint(NewDataItem, Index, Direction)
		8

Question	Answer	Marks
	IF Direction = "Left" THEN // add new node on left **Tree[Index].LeftPointer ← NewNodePointer** 1 ELSE // add new node on right **Tree[Index].RightPointer ← NewNodePointer** **1** ENDIF ENDIF ENDIF ENDPROCEDURE	
2(e)	**1 mark per bullet** • test for base case (null/-1) • recursive call for left pointer • output data • recursive call for right pointer • order, visit left, output, visit right IF Pointer <> NULL 1 THEN TraverseTree(Tree[Pointer].LeftPointer) 1 OUTPUT Tree[Pointer].Data 1 + 1 TraverseTree(Tree[Pointer].RightPointer) 1 ENDIF ENDPROCEDURE	**5**

Question	Answer	Marks

3(a)	**1 mark per bullet**
	• Instantiation of island object and calling DisplayGrid
	• Loop 3 times and Island.HideTreasure
	• Call procedures StartDig and DisplayGrid
	
	Example Python
	
	`Island = IslandClass()`
	`DisplayGrid()` — 1
	`for Treasure in range(3):`
	`  Island.HideTreasure()` — 1
	`StartDig()`
	`DisplayGrid()` — 1
	
	Example Pascal
	
	`var Island : IslandClass;`
	`var Treasure : integer;`
	`begin`
	`  Island := IslandClass.Create();`
	`  DisplayGrid;` — 1
	`  for Treasure := 1 to 3 do`
	`  Island.HideTreasure();` — 1
	`  StartDig;`
	`  DisplayGrid;` — 1
	`end;`
		3

Question	Answer	Marks

	Example VB.NET
	`Dim Island As New IslandClass()`
	`DisplayGrid()` — 1
	`For Treasure = 1 To 3`
	`  Island.HideTreasure()`
	`Next` — 1
	`StartDig()`
	`DisplayGrid()` — 1	

Question	Answer	Marks
3(b)	**1 mark per bullet to max 5** • Class heading and ending (in appropriate place) • Constructor heading and ending (in appropriate place) • Declaring grid with correct dimensions (as private) • Declaring Sand as a constant • Nested loops covering dimensions (0 – 29 and 0 – 9) • Assigning Sand // '.' to each array element	**5**

Example Python

```
class IslandClass:                                          1
   def __init__(self):                                     1
      Sand = '.'                                            1
      self.__Grid = [[Sand for j in range(30)]              1 + 1
                              for i in range(10)]           1
```

Example Pascal

```
type
IslandClass = class                                         1
private
   Grid : array[0..9, 0..29] of char;                       1
public
   constructor Create();
   procedure HideTreasure();
   procedure DigHole(x, y : integer);
   function GetSquare(x, y : integer) : char;
end;
constructor IslandClass.Create();                           1
   const Sand = '.';                                        1
   var i, j : integer;
   begin
      for i := 0 to 9 do
         for j := 0 to 29 do                                1
            Grid[i, j] := Sand;                             1
   end;
```

Question	Answer	Marks

	Example VB.NET
	`Class IslandClass` 1
	`  Private Grid (9, 29) As Char` 1
	`  Public Sub New()` 1
	`  Const Sand = "."` 1
	`  For i = 0 To 9`
	`  For j = 0 To 29` 1
	`  Grid(i, j) = Sand` 1
	`  Next`
	`  Next`
	`  End Sub`
	`End Class`	

3(c)(i)	**1 mark per bullet**
	• Method (getter or property) heading, takes two parameters returns char, and ending
	• Method returns Grid value
	
	Example Python
	`def GetSquare(self, Row, Column) :` 1
	`  return self.__Grid[Row][Column]` 1
	
	Example Pascal
	`function IslandClass.GetSquare( Row, Column : integer) As Char;` 1
	`begin`
	`  Result := Grid[Row, Column];`
	`end;` 1
	
	Example VB.NET
	`Public Function GetSquare(Row As Integer, Column As Integer) As Char` 1
	`  Return Grid(Row, Column)` 1
	`end Function`
		2

Question	Answer	Marks
3(c)(ii)	1 mark per bullet • DisplayGrid header and ending, with two loops with correct limits • Calling **Island.**GetSquare with correct parameters inside iteration • Output an entire row in one line • Output a new line at the end of a row	**4**

Example Python

```
def DisplayGrid() :
   for i in range (10) :
      for j in range (30) :                          1
         print(island.GetSquare(i, j), end='')       1 + 1
      print()                                        1
```

Example Pascal

```
procedure DisplayGrid():
var i, j : integer;
begin
   for i := 0 to 9 do
      begin
         for j := 0 to 29 do                         1
            write(island.GetSquare(i, j)));          1 + 1
         writeLn;                                    1
      end;
 end;
```

Example VB.NET

```
 Sub DisplayGrid()
    For i = 0 to 9
       For j = 0 to 29                               1
          Console.Write(island.GetSquare(i, j))      1 + 1
       Next
       Console.WriteLine()                           1
    Next
 End Sub
```

Question	Answer	Marks

3(d)	**1 mark per bullet to max 5**
	• Method header and Declaring Treasure as a constant
	• Generating a random number for column
	• Generating a random number for row
	• Check whether treasure already at generated location
	• Repeatedly generate new coordinates in a loop
	• Assign Treasure to location
	
	Example Python
	`def HideTreasure(self):`
	`  Treasure = 'T'` — 1
	`  x = randint(0,9)` — 1
	`  y = randint(0,29)` — 1
	`  while self.__Grid[y][x] == Treasure:` — 1+1
	`  x = randint(0,9)`
	`  y = randint(0,29)`
	`  self.__Grid[y][x] = Treasure` — 1
	
	Example Pascal
	`procedure IslandClass.HideTreasure();`
	`  const Treasure = 'T';`
	`  var x, y : integer;` — 1
	`  begin`
	`  repeat`
	`  x := Random(10);` — 1
	`  y := random(30);` — 1
	`  until Grid[x, y] <> Treasure;` — 1+1
	`  Grid[x, y] := Treasure;` — 1
	`  end;`
		Max 5

Question	Answer	Marks

	Example VB.NET
	`Public Sub HideTreasure()`
	`  Const Treasure = "T"`
	`  Dim RandomNumber As New Random`
	`  Dim x, y As Integer`
	`  Do`
	`  x = RandomNumber.Next(0, 10)`
	`  y = RandomNumber.Next(0, 30)`
	`  Loop Until Grid(x, y) <> Treasure`
	`  Grid(x, y) = Treasure`
	`End Sub`
		1
		
		1
		1
		1+1
		1

Question	Answer	Marks

3(e)(i)	**1 mark per bullet**
	• Method heading, with two parameters & Declaring constants for Treasure, Hole and FoundTreasure
	• Check if treasure at parameter locations
	• Set to FoundTreasure (X) and Set to Hole (O)
	
	Example Python
	`def DigHole(self, x, y) :`
	`  Treasure = 'T'`
	`  Hole = 'O'` — 1
	`  Foundtreasure = 'X'`
	`  if self.__Grid[x][y] == Treasure:` — 1
	`  self.__Grid[x][y] = Foundtreasure`
	`  else :` — 1
	`  self.__Grid[x][y] = Hole`
	`  return`
	
	Example Pascal
	`procedure IslandClass.DigHole(x, y : integer);`
	`  const Treasure = 'T';`
	`  const Hole = 'O';`
	`  const Foundtreasure = 'X';` — 1
	`  begin`
	`  if Grid[x, y] = Treasure` — 1
	`  then`
	`  Grid[x, y] := Foundtreasure`
	`  else`
	`  Grid[x, y] := Hole;` — 1
	`  end;`
		3

Question	Answer	Marks

	Example VB.NET
	`Public Sub DigHole(x As Integer, y As Integer)`
	`  Const Treasure = "T"`
	`  Const Hole = "O"`
	`  Const Foundtreasure = "X"` — 1
	`  If Grid(x, y) = Treasure Then` — 1
	`  Grid(x, y) = Foundtreasure`
	`  Else`
	`  Grid(x, y) = Hole` — 1
	`  End If`
	`End Sub`	

Question	Answer	Marks
3(e)(ii)	**1 mark per bullet to max 5** • Prompt to user for position down and across, read positions input as an IntegerValidation for position row – between 0 and 9 • Validation for position column- between 0 and 29 • Exception handling/pass for validation • Ask for repeated input until valid (for both row and column) • Call Island.DigHole method with the coordinates **Example Python**	**Max 5**

```
def StartDig() :
   Valid = False
   while not Valid :      # validate down position                    1
      try:
         x = int(input("position down <0 to 9> ? "))                  1
         if x >= 0 and x <= 9 :                                       1
            Valid = True
      except:
         Valid = False
   Valid = False
   while not Valid :      # validate across position
      try :
         y = int(input("position across <0 to 29> ? "))               1
         if y >= 0 and y <= 29 :                                      1
            Valid = True
      except :
         Valid = False
   island.DigHole(x, y)                                               1
   return
```

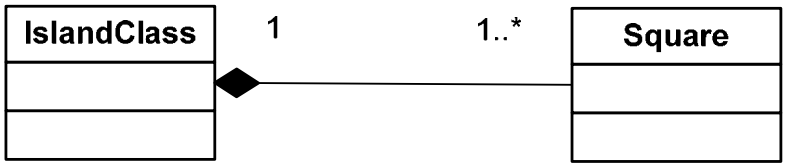
Question	Answer	Marks

	Example Pascal
	`procedure StartDig;`
	`var xString, yString : String;`
	`  x, y : integer;`
	`begin`
	`  Valid := False;`
	`  repeat`
	`  Write('position down <0 to 9>? '); ReadLn(xString);` 1
	`  try`
	`  x := StrToInt(xString);`
	`  if (x >= 0) AND (x <= 9)` 1
	`  then`
	`  Valid := True;`
	`  except`
	`  Valid := False;`
	`  until Valid;`
	`  Valid := False;`
	`  repeat`
	`  Write(position across <0 to 29> ? '); ReadLn(yString);` 1
	`  try`
	`  y := StrToInt(yString);`
	`  if (y >= 0) AND (y <= 29)` 1
	`  then`
	`  Valid := True;`
	`  except`
	`  Valid := False;`
	`  until Valid;` 1
	`  island.DigHole(x,y);` 1
	`end;`	

Question	Answer	Marks

	Example VB.NET
	`Sub StartDig()`
	`  Dim x, y As Integer`
	`  Dim Valid = False`
	`  Do`
	`  Console.Write("Position down <0 to 9>? ")`
	`  Try`
	`  x = CInt(Console.ReadLine())` — 1
	`  If (x >= 0) AND (x <= 9) Then` — 1
	`  Valid = True`
	`  End If`
	`  Catch`
	`  Valid = False 'accept different types of exceptions`
	`  End Try`
	`  Loop Until Valid`
	`Valid = False`
	`  Do`
	`  Console.Write("Position across <0 to 29> ? ")`
	`  Try`
	`  y = int(Console.ReadLine())` — 1
	`  If (y >= 0) AND (y <= 29) Then` — 1
	`  Valid = True`
	`  End IF`
	`  Catch`
	`  Valid = False`
	`  End Try`
	`  Loop until Valid` — 1
	`  island.DigHole(x, y)` — 1
	`End Sub`	

3(f)(i)	containment/aggregation	**1**

Question	Answer	Marks
3(f)(ii)	• IslandClass box and Square Box, with correct connection • One at IslandClass and one .. * at Square 	**Max 2**