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**COMPUTER SCIENCE**

**9608/43**

Paper 4 Written Paper

**May/June 2017**

MARK SCHEME

Maximum Mark: 75

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**Published**

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This document consists of **13** printed pages.

Question	Answer				Marks	
1(a)	Label	Op code	Operand	Comment	} 1 1 1 + 1 1 1 1 1 1 1 1	8
	START:	IN		// INPUT character		
		STO	CHAR	// store in CHAR		
		LDM	#65	// Initialise ACC (ASCII value for 'A' is 65)		
	LOOP:	OUT		// OUTPUT ACC		
		CMP	CHAR	// compare ACC with CHAR		
		JPE	ENDFOR	// if equal jump to end of FOR loop		
		INC	ACC	// increment ACC		
		JMP	LOOP	// jump to LOOP		
	ENDFOR:	END				
	CHAR:					
1(b)	START:	LDD	NUMBER		1 1 1 1 1 1 1 1 1 1 1	7
		AND	MASK	// set to zero all bits except sign bit		
		CMP	#0	// compare with 0		
		JPN	ELSE	// if not equal jump to ELSE		
	THEN:	LDM	#80	// load ACC with 'P' (ASCII value 80)		
		JMP	ENDIF			
	ELSE:	LDM	#78	// load ACC with 'N' (ASCII value 78)		
	ENDIF:	OUT		//output character		
		END				
	NUMBER:	B00000101		// integer to be tested		
	MASK:	B10000000		// show value of mask in binary here		

Question	Answer	Marks
2(a)	<p>1 mark for the declaration of the array.  1 mark for assigning a 0 to Customer ID (CustomerID ← 0)  1 mark for getting the correct record (Customer[x].)  1 mark for setting up a loop to go <u>from 0 to 199</u></p> <pre> DECLARE Customer : ARRAY[0 : 199] OF CustomerRecord FOR x ← 0 TO 199     Customer[x].CustomerID ← 0 ENDFOR </pre> <p style="text-align: right;">1 1 1+1</p>	<b>4</b>
2(b)(i)	<pre> PROCEDURE InsertRecord(BYVAL NewCustomer : CustomerRecord)     TableFull ← FALSE     // generate hash value     Index ← Hash(NewCustomer.CustomerID)     Pointer ← Index // take a copy of index      // find a free table element     WHILE Customer[Pointer].CustomerID &gt; 0         Pointer ← Pointer + 1         // wrap back to beginning of table if necessary         IF Pointer &gt; 199             THEN                 Pointer ← 0             ENDIF         // check if back to original index         IF Pointer = Index             THEN                 TableFull ← TRUE             ENDIF     ENDWHILE     IF NOT TableFull         THEN             Customer[Pointer] ← NewCustomer         ELSE             OUTPUT "Error"         ENDIF     ENDPROCEDURE </pre> <p style="text-align: right;">1 1 1 1 1 1 1 1</p>	<b>9</b>

Question	Answer	Marks
2(b)(ii)	<pre> FUNCTION SearchHashTable(BYVAL SearchID : INTEGER) RETURNS INTEGER   // generate hash value   Index ← <b>Hash(SearchID)</b>   // check each record from index until found or not there   WHILE (<b>Customer[Index].CustomerID &lt;&gt; SearchID</b>)     AND (<b>Customer[Index].CustomerID &gt; 0</b>)     <b>Index ← Index + 1</b>   // wrap if necessary   IF <b>Index &gt; 199</b>     THEN       <b>Index ← 0</b>     ENDIF   ENDWHILE   // has customer ID been found?    IF <b>Customer[Index].CustomerID = SearchID</b>     THEN       <b>RETURN Index</b>     ELSE       <b>RETURN -1</b>     ENDIF ENDFUNCTION </pre>	<p style="text-align: right;"><b>9</b></p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p>
2(b)(iii)	A record out of place may not be found	<b>1</b>

Question	Answer	Marks
3	<pre> FUNCTION Find(BYVAL Name : STRING,               BYVAL Start : INTEGER,               BYVAL Finish : INTEGER) RETURNS INTEGER // base case IF <b>Finish &lt; Start</b> THEN   RETURN -1 ELSE   Middle ← <b>(Start + Finish) DIV 2</b>   IF <b>NameList[Middle] = Name</b>   THEN     RETURN <b>Middle</b>   ELSE // general case     IF SearchItem &gt; <b>NameList[Middle]</b>     THEN       <b>Find(Name, Middle + 1, Finish)</b>     ELSE       <b>Find(Name, Start, Middle - 1)</b>     ENDIF   ENDIF ENDIF ENDFUNCTION           </pre>	<p><b>7</b></p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
4(a)(i)	containment/aggregation	1
4(a)(ii)	<pre> classDiagram     class LinkedList     class Node     LinkedList "1" *-- "0..*" Node           </pre> <p>1 mark for the two classes (in boxes) and connection with correct end point            1 mark for 0 ..* 0</p>	Max 2

Question	Answer	Marks
<p>4(b)</p>	<p><b>mark as follows:</b></p> <ul style="list-style-type: none"> <li>• Class heading and ending</li> <li>• Constructor heading and ending</li> <li>• Parameters in constructor heading</li> <li>• Declaration of (private) attributes : Pointer, Data</li> <li>• Assignment of parameters to Pointer and Data</li> </ul> <p><b>Python Example</b></p> <pre> class Node:     def __init__(self, D, P):         self.__Data = D         self.__Pointer = P         return                     </pre> <p><b>Example Pascal</b></p> <pre> type     Node = class         private             Data : String;             Pointer : Integer;         public             constructor Create(D : string; P : integer);             procedure SetPointer(P : Integer);             procedure SetData(D : String);             function GetData() : String;             function GetPointer() : Integer;         end;     constructor Node.Create(D : string; P : integer);     begin         Data := D;         Pointer := P;     end;                     </pre> <p><b>Example VB.NET</b></p> <pre> Class Node     Private Data As String     Private Pointer As Integer     Public Sub New(ByVal D As String, ByVal P As Integer)         Data = D         Pointer = P     End Sub End Class                     </pre>	<p><b>5</b></p> <p>1  1 + 1  1  1</p> <p>1  1  ignore  1+1  1</p> <p>1  1  1+1  1</p>
<p>4(c)(i)</p>	<p>A pointer that doesn't point to any data/node/address</p>	<p><b>1</b></p>

Question	Answer	Marks
4(c)(ii)	-1 (accept NULL) The array only goes from 0 to 7 // the value is not an array index	<b>2</b>
4(c)(iii)	<p><b>mark as follows:</b></p> <ul style="list-style-type: none"> <li>• Class and constructor heading and ending</li> <li>• Declare private attributes (HeadPointer, FreeListPointer, NodeArray)</li> <li>• Initialise HeadPointer to null</li> <li>• Initialise FreeListPointer to 0</li> <li>• Looping 8 times ...</li> <li>• Creating empty node in NodeArray</li> <li>• Use .SetPointer method to point each new node to next node</li> <li>• Set last node pointer to null pointer</li> </ul> <p><b>Python Example</b></p> <pre> class LinkedList:     def __init__(self):         self.__HeadPointer = - 1         self.__FreeListPointer = 0         self.__NodeArray = []         for i in range(8):             ThisNode = Node("", (i + 1))             self.__NodeArray.append(ThisNode)         self.__NodeArray[7].SetPointer(- 1) </pre> <p><b>Example Pascal</b></p> <pre> type LinkedList = class     private         HeadPointer : Integer;         FreeList : Integer;         NodeArray : Array[0..7] of Node;     public         constructor Create();         procedure FindInsertionPoint(NewData : string; var             PreviousPointer, NextPointer : integer);         procedure AddToList(NewData : string);         procedure OutputListToConsole(); end; constructor LinkedList.Create(); var i : integer; begin     HeadPointer := -1;     FreeList := 0;     for i := 0 To 7 do         NodeArray[i] := Node.Create('', (i + 1));     NodeArray[7].SetPointer(-1); end; </pre>	<b>Max 7</b>

Question	Answer	Marks
	<p><b>Example VB.NET</b></p> <pre> Class LinkedList   Private HeadPointer As Integer   Private FreeList As Integer   Private NodeArray(7) As Node    Public Sub New()     HeadPointer = -1     FreeList = 0     For i = 0 To 7       NodeArray(i) = New Node("", (i + 1))     Next     NodeArray(7).SetPointer(-1)   End Sub End Class </pre>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
4(c)(iv)	<ul style="list-style-type: none"> <li>• Creating instance of LinkedList assigned to contacts</li> </ul> <p><b>Python Example</b></p> <pre>contacts = LinkedList()</pre> <p><b>Pascal Example</b></p> <pre>var contacts : LinkedList;     contacts := LinkedList.Create;</pre> <p><b>VB.NET Example</b></p> <pre>Dim contacts As New LinkedList</pre>	1



Question	Answer	Marks
4(c)(v)	<p><b>mark as follows:</b></p> <ul style="list-style-type: none"> <li>• Start with HeadPointer</li> <li>• Output node data</li> <li>• Loop until null pointer</li> <li>• Following pointer to next node</li> <li>• Use of getter (ie GetData/GetPointer)</li> </ul> <p><b>Python Example</b></p> <pre>def OutputListToConsole(self) :     Pointer = self.__HeadPointer     while Pointer != -1 :         print(self.__NodeArray[Pointer].GetData())         Pointer = self.__NodeArray[Pointer].GetPointer()     print()     return</pre> <p><b>Pascal Example</b></p> <pre>procedure LinkedList.OutputListToConsole(); var Pointer : integer; begin     Pointer := HeadPointer;     while Pointer &lt;&gt; -1 do         begin             WriteLn(NodeArray[Pointer].GetData);             Pointer := NodeArray[Pointer].GetPointer;         end; end;</pre> <p><b>VB.NET Example</b></p> <pre>Public Sub OutputListToConsole()     Dim Pointer As Integer     Pointer = HeadPointer     Do While Pointer &lt;&gt; -1         Console.WriteLine(NodeArray(Pointer).GetData)         Pointer = NodeArray(Pointer).GetPointer     Loop End Sub</pre>	<p><b>5</b></p>

Question	Answer	Marks
4(c)(vi)	<p><b>mark as follows:</b></p> <ul style="list-style-type: none"> <li>• Store free list pointer as NewNodePointer</li> <li>• Store new data item in free node</li> <li>• Adjust free pointer</li> <li>• F list is currently empty</li> <li>• Make the node the first node</li> <li>• Set pointer of this node to Null Pointer</li> <li>• Find insertion point</li> <li>• If previous pointer is Null pointer</li> <li>• Link this node to front of list</li> <li>• Link new node between Previous node and next node</li> </ul> <p><b>Python Example</b></p> <pre>def AddToList(self, NewData):      NewNodePointer = self.__FreeListPointer      self.__NodeArray[NewNodePointer].SetData(NewData)      self.__FreeListPointer = self.__NodeArray[self.__FreeListPointer].GetPointer()      if self.__HeadPointer == -1:          self.__HeadPointer = NewNodePointer         self.__NodeArray[NewNodePointer].SetPointer(-1)     else:         PreviousPointer, NextPointer = self.FindInsertionPoint(NewData)         if PreviousPointer == -1 :              self.__NodeArray[NewNodePointer].SetPointer (self.__HeadPointer)             self.__HeadPointer = NewNodePointer         else:              self.__NodeArray[NewNodePointer].SetPointer(NextPointer)             self.__NodeArray[PreviousPointer].SetPointer(NewNodePointer)</pre>	<b>Max 6</b>

Question	Answer	Marks
	<p><b>Pascal Example</b></p> <pre> procedure LinkedList.AddToList(NewData : string); var NewNodePointer , PreviousPointer,                                      NextPointer : integer;  begin   // make a copy of free list pointer   NewNodePointer := FreeListPointer;   // store new data item in free node   NodeArray[NewNodePointer].SetData(NewData);   // adjust free pointer   FreeListPointer := NodeArray[FreeListPointer].GetPointer;   // if list is currently empty   if HeadPointer = -1   then     // make the node the first node     begin       HeadPointer := NewNodePointer;       // set pointer to Null pointer       NodeArray[NewNodePointer].SetPointer(-1);     end   else     // find insertion point     begin       FindInsertionPoint(NewData, PreviousPointer,                                      NextPointer);       // if previous pointer is Null pointer       if PreviousPointer = -1       then         // link node to front of list         begin           NodeArray[NewNodePointer]             .SetPointer(HeadPointer);           HeadPointer := NewNodePointer ;         end       else         // link new node between           Previous node and next node         begin           NodeArray[NewNodePointer ]             .SetPointer(NextPointer);           NodeArray[PreviousPointer]             .SetPointer(NewNodePointer);         end;       end;     end;   end; end; </pre>	

Question	Answer	Marks
	<p><b>VB.NET Example</b></p> <pre> Public Sub AddToList(ByVal NewData As String)     Dim NewNodePointer, PreviousPointer, NextPointer As Integer     ' make copy of free list pointer     NewNodePointer= FreeListPointer     ' store new data item in free node     NodeArray(NewNodePointer).SetData(NewData)     ' adjust free pointer     FreeListPointer = NodeArray(FreeListPointer).GetPointer     ' if list is currently empty     If HeadPointer = -1 Then         ' make the node the first node         HeadPointer = NewNodePointer         ' set pointer to Null pointer         NodeArray(NewNodePointer).SetPointer(-1)     Else         ' find insertion point         FindInsertionPoint(NewData, PreviousPointer, NextPointer)         ' if previous pointer is Null pointer         If PreviousPointer = -1 Then             ' link to front of list             NodeArray(NewNodePointer).SetPointer(HeadPointer)             HeadPointer = NewNodePointer         Else             ' link new node between Previous node and next node             NodeArray(NewNodePointer).SetPointer(NextPointer)             NodeArray(PreviousPointer).SetPointer(NewNodePointer)         End If     End If End Sub </pre>	

Question	Answer	Marks
	<p>Pseudocode for reference:</p> <pre> PROCEDURE AddToList(NewData)   // remember value of free list pointer   NewNodePointer ← FreeListPointer   // add new data item to free node pointed to by free list   NodeArray[NewNodePointer].Data ← NewData   // adjust free pointer to point to next free node   FreeListPointer ← NodeArray[FreeList].Pointer   // is list currently empty?   IF HeadPointer = NullPointer     THEN       // make the node the first node       HeadPointer ← NewNodePointer       // set pointer of new node to Null pointer       NodeArray[NewNodePointer].Pointer ← NullPointer     ELSE       // find insertion point       CALL FindInsertionPoint(NewData, PreviousPPointer, NextPointer)       // if previous pointer is Null pointer       IF PreviousPointer = NullPointer         THEN           // link new node to front of list           NodeArray[NewNodePointer].Pointer ← HeadPointer           HeadPointer ← NewNodePointer         ELSE           // link new node between previous node and next node           NodeArray[NewNodePointer].Pointer ← NextPointer           NodeArray[PreviousPointer].Pointer ← NewNodePointer         END IF       ENDIF     END PROCEDURE </pre>	