Information

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This paper is in four parts: part A, part B, part C and part D.

You should answer **ALL questions from part A** and **ALL questions from TWO** of the remaining parts (parts B, C and D). For example, you answer all questions from part A and all questions from parts B and D (or any other pair selected from parts B, C and D).

Part A carries 40 marks. Parts B, C and D carry 30 marks each.

The marks for each question are indicated at the right side of it.

There are 100 marks available on this paper.

Calculators may be used in this examination; however, calculators which display graphics, text or algebraic equations are not allowed.

Information

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The following 16 questions belong to Part A of this exam.

Question **1**

Not yet answered

Marked out of 2.50

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A function described as being $O(N^2)$ means:

Select one:

- a. it grows slower than quadratically
- b. it grows quadratically
- c. it grows no faster than quadratically
- d. none of the other answers
- e. it grows no slower than quadratically

Question **2**

Not yet answered

Marked out of 2.50

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Order the following functions in ascending order of growth (i.e. slowest growth at large value of N receives number 1; the fastest growth receives number 5).

$N^{1.5}$ Choose...

2^N Choose...

$N^{2.5}$ Choose...

N Choose...

$N!$ Choose...

Choose...
2
5
3
1
4

Question **3**

Not yet answered

Wh should replace Z for function A to return the sum of a and b?

Ass ial arguments to the function A are positive integers.

Question **3**

Not yet answered

Marked out of 2.50

Flag question

Edit question

What code fragment should replace Z for function A to return the sum of a and b? Assume that the initial arguments to the function A are positive integers.

```
function A(a,b)
    if (a==0)
        return b
    else
        return Z+1
    end if
end function
```

Select one:

- a. A(a - 1, b - 1)
- b. A(a - 1, b)
- c. A(a, b - 1)
- d. A(a - 1, b + 1)
- e. none of the others

Question **4**

Not yet answered

Marked out of 2.50

Flag question

Edit question

Given the following function A(a,b), what does A(10,13) return?

```
function A(a,b)
    if (a==0)
        return b
    else
        return A(a-1,b+1)
    end if
end function
```

Answer:

Question **5**

Not yet answered

Marked out of 2.50

Flag question

Edit question

For the following algorithm:

A:array of integers
k:maximum value stored in A

```
function ALG(A,k)
    C ← new array(k+1), initialise with zeros
    R ← new array(length(A)), initialise with zeros
    pos ← 0
    for 0 ≤ j < length(A) do
          C[A[j]] ← C[A[j]] + 1
    for 0 < i < (k+1) do
          for pos ≤ r < pos+C[i] do
                R[r]=i
          pos=r
   return R
end function
```

which of the following statements is true?

Select one:

- a. None of the others
- b. Advantage: constant memory space. Drawback:Cubic running time
- c. Advantage: linear running time. Drawback: It can only sort integer numbers
- d. Advantage: It works with any type of numbers. Drawback: quadratic running time
- e. Advantage: linear running time. Drawback:T(N) is Omega(N^2)

Question **6**

Not yet answered

Marked out of 2.50

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Edit question

The following piece of pseudocode:

```
if(A[i]>A[i+1])
    tmp=A[i]
    A[i]=A[i+1]
    A[i+1]=tmp
```

is the core part of:

Select one:

- a. a sorting algorithm
- b. none of the others
- c. a linked list operation
- d. a search algorithm
- e. a collision resolution algorithm

Question **7**

Not yet answered

Marked out of 2.50

Flag question

Edit question

A separate-chaining hash table with 8 buckets uses the hash function f(x) = x mod 8. If the following numbers are inserted in the hash table: [193, 85, 228], what is the length of the longest chain in the hash table?

Answer:

Question **8**

Not yet answered

Marked out of 2.50

Flag question

Edit question

An open-addressing hash table with 8 buckets uses the hash function h(x) = x mod 8, and linear probing to resolve collisions. If the keys [67, 197, 29, 46] are inserted in that order into the hash table, what is the greatest number of steps a key is from its natural position in the table?

Answer:

Question **9**

Not yet answered

Marked out of 2.50

Flag question

Edit question

In the list: head/0x1 -> 2/0x3 -> 7/0x7 -> 8/NULL, node 7 is deleted. What is the new content of the address part of node 2 after the deletion?

Select one:

- a. none of the others
- b. NULL
- c. 7
- d. 0x7
- e. 0x3

Question **10**

Not yet answered

Marked out of 2.50

Flag question

Edit question

What is the return value from this block of pseudocode?

```
q ← new Queue()
enqueue (76,q)
dequeue (q)
enqueue (65,q)
dequeue (q)
 isempty(q)
enqueue (67,q)
peek(q)
return peek (q)
```

Select one:

- a. none of the others
- b. TRUE
- c. FALSE
- d. 65
- e. 67

Question **11**

Not yet answered

Marked out of 2.50

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Edit question

The following numbers are inserted (in this exact order) into a binary search tree: 10, 20, 5, 25, 1, 8, 15. When performing a post-order traversal in the tree, in what order will the nodes be visited?

Select one:

- a. 1, 5, 8, 10, 15, 20, 25
- b. none of the others
- c. 10, 5, 20, 1, 8, 15, 25
- d. 1, 8, 5, 15, 25, 20, 10
- e. 10, 5, 1, 8, 20, 15, 25

Question **12**

Not yet answered

Marked out of 2.50

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Edit question

The following numbers are inserted (in this exact order) into a binary search tree: 3, 5, 1, 4, 2. When performing a in**-order** traversal in the tree, in what order will the nodes be visited?

Select one:

- a. none of the others
- b. 3, 1, 2, 4, 5
- c. 1, 2, 3, 4, 5
- d. 5, 4, 3, 2, 1
- e. 3, 2, 1, 5, 4

Question **13**

Not yet answered

Marked out of 2.50

Flag question

Edit question

In the implicit min-heap with contents: [4,9,6,17,26,8,16,19,69,32,93,55,50], what is the left-child of 26?

Answer:

Question **14**

Not yet answered

Marked out of 2.50

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Edit question

An empty **max-heap** is initialised by inserting elements one at a time, in order, from the array [55,20,11,68,71,70,98,86]. What are the final contents of the newly-built heap?

Select one:

- a. [98, 70, 86, 55, 68, 11, 71, 20]
- b. [98, 86, 70, 71, 11, 55, 20, 68]
- c. [98, 86, 70, 68, 71, 55, 11, 20]
- d. none of the other answers
- e. [98, 86, 55, 71, 70, 11, 20, 68]

Question **15**

Not yet answered

Marked out of 2.50

Flag question

Edit question

The directed graph G is represented as an adjacency matrix:

-1	8	1	2
-1	-1	7	4
3	-1	6	-1
-1	-1	-1	5

with vertices in alphabetical order.
Which of the following adjacency lists represents the same graph?

Select one:

a.

T: [(T, U, 8), (T, W, 1)]
U: [(U, W, 7), (U, X, 4)]
W: [(W, T, 3), (W, W, 6)]
X: [(X, T, 2), (X, X, 5)]

b.

T: [(T, U, 8), (T, W, 1), (T, X, 2)]
U: [(U, W, 7), (U, X, 4)]
W: [(W, T, 3), (W, W, 6)]
X: [(X, X, 5)]

c.

T: [(T, U, 8), (T, W, 1), (T, X, 2)]
U: [(U, X, 4)]
W: [(W, T, 3), (W, W, 6)]
X: [(X, W, 7), (X, X, 5)]

d.

T: [(T, U, 8), (T, W, 1)]
U: [(U, W, 7), (U, X, 4)]
W: [(W, T, 3), (W, W, 6)]
X: [(X, T, 2), (X, X, 5)]

e.

T: [(T, U, 8), (T, W, 1), (T, X, 2)]
U: [(U, W, 7), (U, X, 4)]
W: [(W, U, 3), (W, W, 6)]
X: [(X, X, 5)]

Question **16**

Not yet answered

Marked out of 2.50

Flag question

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The undirected graph G is represented as an adjacency matrix:

15	2	7	4	1
2	14	13	6	8
7	13	11	5	12
4	6	5	9	3
1	8	12	3	10

What is the cost of the minimum spanning tree?

Answer:

Information

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This is Part B. Part B has 9 questions.

Information

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Edit question

The following algorithms (A1, A2 and A3) solve the same problem. To do so, they receive as input argument:

- A: array of integers between 0 and 9 (both inclusive)
- N: number of elements of array A
- B: array of 10 zeros

ALGORITHM 1

```
function A1(A,N,B)
    for 0 <= i < N
        B[A[i]]= B[A[i]]+1
    return B
end function
```

ALGORITHM 2

```
function A2(A,N,B)
    for 0 <= i <10
        for 0 <= j < N
            if(A[j]==i)
                B[i]=B[i]+1
    return B
end function
```

ALGORITHM 3

```
function A3(A,N,B)
    if(N==0)
        return B
    else
        B[A[N-1]]=B[A[N-1]]+1
        A3(A,N-1,B)
end function
```

Question **1**

Not yet answered

Marked out of 3.00

Flag question

Edit question

Assume that the content of array A is [9,1,1,5,5,5] and that array B is initialised to [0,0,0,0,0,0,0,0,0,0].

What is the content of B[0] after executing algorithm A1?

Answer:

Question **2**

Not yet answered

Marked out of 3.00

Flag question

Edit question

Assume that the content of array A is [9,1,1,5,5,5] and that array B is initialised to [0,0,0,0,0,0,0,0,0,0].

What is the content of B[1] after executing algorithm A2?

Answer:

Question **3**

Not yet answered

Marked out of 3.00

Flag question

Edit question

Assume that the content of array A is [9,1,1,5,5,5] and that array B is initialised to [0,0,0,0,0,0,0,0,0,0].

What is the content of B[5] after executing algorithm A3?

Answer:

Question **4**

Not yet answered

Marked out of 4.00

Flag question

Edit question

The task performed by the algorithms is:

Select one:

- a. Sorting the numbers in A and store them in B in ascending order
- b. none of the others
- c. Storing in B[i] the number of times that number i appears in A
- d. Storing in B the sum of the numbers stored in A
- e. Sorting the numbers in A and store them in B in descending order

Question **5**

Not yet answered

Marked out of 3.00

Flag question

Edit question

The time complexity of algorithm A1 is:

Select one or more:

- a. O(N logN)
- b. O(N^2)
- c. O(1)
- d. O(logN)
- e. O(N)

Question **6**

Not yet answered

Marked out of 3.00

Flag question

Edit question

The time complexity of algorithm A2 is:

Select one:

- a. Theta(10+N)
- b. none of the others
- c. Theta(N)
- d. Theta(10N)
- e. Theta(N^2)

Question **7**

Not yet answered

Marked out of 3.50

Flag question

Edit question

The recurrrence equation describing the running time of algorithm A3 is:

Select one:

- a. T(N)=2*T(N-1)+C
- b. T(N)=T(N-1)+C
- c. T(N)=T(N-1)*C
- d. T(N)=T(N/2)+C
- e. none of the others

Question **8**

Not yet answered

Marked out of 3.50

Flag question

Edit question

The time complexity of algorithm A3 is:

Select one or more:

- a. Omega(log N)
- b. Omega (N^2)
- c. Omega(1)
- d. Omega(N)
- e. Omega(N log N)

Question **9**

Not yet answered

Marked out of 4.00

Flag question

Edit question

In terms of time complexity:

Select one:

- a. Algorithms A1 and A2 are better than A3. I recommend implementing either A1 or A2.
- b. Algorithm A1 is better than the other two. I recommend implementing algorithm A1 to solve the problem.
- c. Algorithm A3 is better than the other two. I recommend implementing algorithm A3 to solve the problem.
- d. Algorithm A2 is better than the other two. I recommend implementing algorithm A2 to solve the problem.
- e. The 3 algorithms are the same, any of them can be implemented.

Information

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Edit question

This is Part C. Part C is made of 6 questions.

Question **1**

Not yet answered

Marked out of 5.00

Flag question

Edit question

The following **recursive** function returns true if number x is found in the linked list and false otherwise.

```
function FIND(head,x)
  if [          ]
      return false
  else
      if [          ]
          return true
      else
          [          ]
end function
```

Please, complete the missing lines.

(head==NULL)	(head->data==x)	FIND(head->next,x)	(head!=NULL)
FIND(head->data,x)	(head->next==x)		

Question **2**

Not yet answered

Marked out of 5.00

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Edit question

Build the pseudocode of the function SUM(head) that receives as input argument the head of a linked list and returns the sum of all even positive numbers stored in it. If the list is empty, the number -1 is returned.

function SUM(head)

[ ]

if [ ]

return -1

else

[ ]

[ ]

[ ]

[ ]

[ ]

end function

sum=0	(head==NULL)
while(head!=NULL)	if(head->data>0 AND head->data%2==0)
sum=sum+head->data	head=head->next
return sum	if(head->data>0 AND head->data%2!=0)
head=head->data	(head!=NULL)

Question **3**

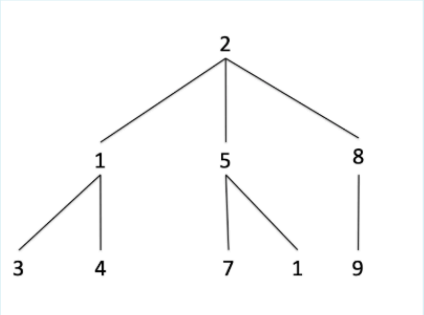
Not yet answered

Marked out of 5.00

Flag question

Edit question

In a ternary tree every node might have a left child, a centre child and a right child. For the following ternary tree:



What is the return value of the following algorithm?

```
function X(root)
    result=0
    if (root==NULL)
        return 0
    else
           result=result+root->data + X(root->left) + X(root->centre) + X(root->right)
end function
```

Answer:

Question **4**

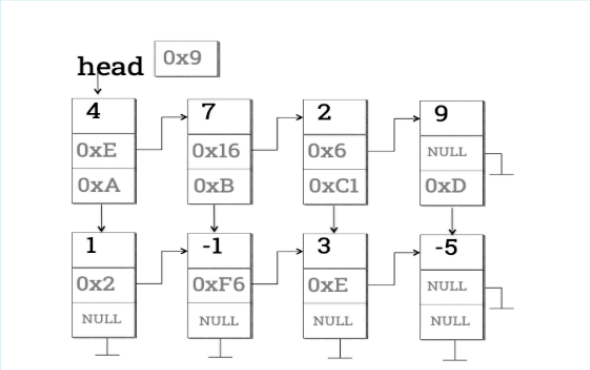
Not yet answered

Marked out of 5.00

Flag question

Edit question

A new data structure, known as the grid, has been devised. The following image shows an example of a grid of 2 rows and 4 columns:



Every node in the grid has 3 components: a data part (data), a pointer to the right node (right) and a pointer to the node below (below).

What is the return value of the function W when executed using the grid shown above?

```
function W(head)
    tmp=head
    result=0
    while(tmp!=NULL)
         result=result+ tmp->data
         if(result%2==0)
                tmp=tmp->right
         else
                 tmp=tmp->below
    return result
end function
```

Answer:

Information

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Edit question

For the following questions (questions 5 and 6), consider the following algorithm that receives as input argument a stack containing positive integers.

```
function ALG1(s1)
   s2= new Stack()
   result=0
    while(s1.ISEMPTY==FALSE)
         x=s1.POP()
         s2.PUSH(x)
         if(x>result)
               result=x
   while(s2.ISEMPTY==FALSE)
         s1.PUSH(s2.POP())
   return result
end function
```

Question **5**

Not yet answered

Marked out of 5.00

Flag question

Edit question

What is the return value after executing ALG1 with the following stack as input argument?

```
| 5 | <-- top
-----
| 1 |
-----
| 3 |
-----
| 2 |
-----
| 4 |
-----
```

Answer:

Question **6**

Not yet answered

Marked out of 5.00

Flag question

Edit question

What is the task performed by ALG1?

Select one or more:

- a. returning the last element pushed into stack s1
- b. none of the others
- c. returning the number of elements stored in the stack s1
- d. returning the maximum value stored in the stack s1
- e. returning the number of elements transferred from stack s1 to stack s2

Information

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Part D begins here. Part D is made of 6 questions.

Information

Flag question

Edit question

For the next two questions (Q1 and Q2), please consider the following pseudocode:

```
A: array of integer numbers
N: number of elements in A

function F1(A,N)
      for 0 <= k <N/2
           a=k
           b=N-1-k
           for  k <= i < N-k
               if(A[i]<A[a])
                   a=i
               if(A[i]>A[b])
                   b=i
           swap(A,k,a)
           if(k==b)
               swap(A,N-1-k,a)
           else
               swap(A,N-1-k,b)
      end for
      return A
end function
```

The function swap(A, x, y) swaps the contents stored in positions x and y in array A.
For example, consider the array A=[2, 7, 8].
After executing swap(A,1,2) the new content of the array is [2, 8, 7].

Question **1**

Not yet answered

Marked out of 5.00

Flag question

Edit question

After executing F1 using [1, 4, 5, 3, 2] as input array

The number stored in position 0 in the output array is Choose...

The number stored in position 1 in the output array is Choose...

The number stored in position 2 in the output array is Choose...

The number stored in position 3 in the output array is Choose...

The number stored in position 4 in the output array is Choose...

Question **2**

Not yet answered

Marked out of 5.00

Flag question

Edit question

What is the task performed by F1?

Select one:

- a. sorting all numbers stored in array A from largest to smallest
- b. sorting half of numbers stored in array A in descending order and the order half in ascending order
- c. sorting half of numbers stored in array A in ascending order and the order half in descending order
- d. none of the others
- e. sorting all numbers stored in array A from smallest to largest

Information

Flag question

Edit question

For the next 2 questions (Q3 and Q4), please consider the following pseudocode:

```
A: array used to store integer numbers
N: number of elements in A
x: a positive integer number

function F2(A,N,x)
    for 0 <= i < N
         print( A[(i+x)%N ]
```

Question **3**

Not yet answered

Marked out of 5.00

Flag question

Edit question

After executing F2 using:

```
A: [1, 2, 3, 4, 5, 6, 7]
N: 7
x: 3
```

as input arguments...

The first number printed on screen is Choose...

The fifth number printed on screen is Choose...

The seventh number printed on screen is Choose...

The third number printed on screen is Choose...

Question **4**

Not yet answered

Marked out of 5.00

Flag question

Edit question

This way of traversing an array is used in:

Select one or more:

- a. implementing queues using arrays
- b. expand & extend (hashing)
- c. separate chaining (hashing)
- d. linear probing (hashing)
- e. implementing stacks using arrays

Information

Flag question

Edit question

For the next 2 questions (Q5 and Q6), please consider the following pseudocode:

```
A: array of integer numbers
function F3(A,low, high)
    if (low < high)
          mid=low+ FLOOR( (high-1)/2 )
          F3(A,low,mid)
          F3(A, mid+1, high)
          F4(A, low, mid, high)
end function

function F4(A,low,mid,high)
1.    for 0 <= i <=mid
2.         B[i]=A[i]
3.    for 0 <= i < (h-mid)
4.         C[i]=A[i+mid+1]
5.    i=0; j=0; k=0
6.    while( i <=mid  AND  j<(h-mid) )
7.          if(B[i]<C[j])
8.              A[k]=B[i]
9.              i=i+1
10.         else
11.              A[k]=C[j]
12.              j=j+1
13.    k=k+1
14.    if(i>mid)
15.         for j <= m < h-mid
16.             A[k]=C[m]
17.             k=k+1
18.    if(j > (h-mid) )
19.         for i <= m <mid+1
20.             A[k]=B[m]
21.             k=k+1
end function
```

Question **5**

Not yet answered

Marked out of 5.00

Flag question

Edit question

Assume that the input arguments to the function F3 are:

```
A: [7, 1, 3, 8]
low: 0
high: 3
```

What is the content of the array immediately before executing function F4 for the first time?

Select one:

- a. none of the others
- b. [8, 7, 3, 1]
- c. [1, 3, 7, 8]
- d. [7, 1, 8, 3]
- e. [1, 7, 3, 8]

Question **6**

Not yet answered

Marked out of 5.00

Flag question

Edit question

What is the task performed by the algorithm F4?

Select one:

- a. none of the other
- b. merging two unsorted parts of the array A: the part from low to mid and the part from mid+1 to high
- c. sorting the numbers of A between the indices low and high in descending order
- d. swapping the numbers between low and mid with the numbers between mid+1 and high
- e. sorting the numbers of A between the indices low and high in ascending order