

COMPUTER SCIENCE

PAPER 1

(THEORY)

(Maximum Marks: 70)

(Time allowed: Three hours)

(Candidates are allowed additional 15 minutes for **only** reading the paper.
They must NOT start writing during this time.)

Answer **all** questions in Part I (compulsory) and **six** questions from Part-II, choosing **two** questions from Section-A, **two** from Section-B and **two** from Section-C.

All working, including rough work, should be done on the same sheet as the rest of the answer.

The intended marks for questions or parts of questions are given in brackets [].

PART I (20 Marks)

Answer **all** questions.

While answering questions in this Part, indicate briefly your working and reasoning, wherever required.

Question 1

- (a) State the law represented by the following proposition and prove it with the help of a truth table: [1]

$$P \vee P = P$$

- (b) State the Principle of Duality. [1]

- (c) Find the complement of the following Boolean expression using De Morgan's law: [1]

$$F(a,b,c) = (b' + c) + a$$

- (d) Draw the logic diagram and truth table for a 2 input XNOR gate. [1]

- (e) If $(\sim P \Rightarrow Q)$ then write its: [1]

(i) Inverse

(ii) Converse

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Question 2

- (a) What is an *interface*? How is it different from a *class*? [2]
- (b) Convert the following infix expression to postfix form: [2]
- $$P * Q / R + (S + T)$$
- (c) A matrix $P[15][10]$ is stored with each element requiring 8 bytes of storage. If the base address at $P[0][0]$ is 1400, determine the address at $P[10][7]$ when the matrix is stored in **Row Major Wise**. [2]
- (d) (i) What is the worst case complexity of the following code segment: [2]
- ```
for (int x = 1; x <= a; x++)
{
 statements;
}
for (int y = 1; y <= b; y++)
{
 for (int z = 1; z <= c; z++)
 {
 statements;
 }
}
```
- (ii) How would the complexity change if all the three loops went to N instead of a, b and c?
- (e) Differentiate between a *constructor* and a *method* of a class. [2]

## Question 3

The following function **magicfun( )** is a part of some class. What will the function **magicfun( )** return, when the value of **n=7** and **n=10**, respectively? Show the dry run/working: [5]

```
int magicfun(int n)
{ if(n == 0)
 return 0;
 else
 return magicfun(n/2) * 10 + (n % 2);
}
```

**PART – II (50 Marks)**

*Answer six questions in this part, choosing two questions from Section A, two from Section B and two from Section C.*

**SECTION - A**

*Answer any two questions.*

**Question 4**

(a) Given the Boolean function  $F(A, B, C, D) = \Sigma (2,3,4,5,6,7,8,10,11)$ .

- (i) Reduce the above expression by using 4-variable Karnaugh map, showing the various groups (i.e. octal, quads and pairs). [4]
- (ii) Draw the logic gate diagram for the reduced expression. Assume that the variables and their complements are available as inputs. [1]

(b) Given the Boolean function  $F(P, Q, R, S) = \pi(0,1,2,4,5,6,8,10)$ .

- (i) Reduce the above expression by using 4-variable Karnaugh map, showing the various groups (i.e. octal, quads and pairs). [4]
- (ii) Draw the logic gate diagram for the reduced expression. Assume that the variables and their complements are available as inputs. [1]

**Question 5**

(a) A school intends to select candidates for an Inter-School Essay Competition as per the criteria given below: [5]

- The student has participated in an earlier competition and is very creative.

**OR**

- The student is very creative and has excellent general awareness, but has not participated in any competition earlier.

**OR**

- The student has excellent general awareness and has won prize in an inter-house competition.

The inputs are:

| INPUTS |                                         |
|--------|-----------------------------------------|
| A      | participated in a competition earlier   |
| B      | is very creative                        |
| C      | won prize in an inter-house competition |
| D      | has excellent general awareness         |

(In all the above cases 1 indicates yes and 0 indicates no).

Output : **X** [1 indicates yes, 0 indicates no for all cases]

Draw the truth table for the inputs and outputs given above and write the POS expression for **X(A,B,C,D)**.

- (b) State the application of a *Half Adder*. Draw the truth table and circuit diagram for a Half Adder. [3]
- (c) Convert the following Boolean expression into its canonical POS form: [2]  

$$F(A,B,C) = (B + C') \cdot (A' + B)$$

#### Question 6

- (a) What is a *Multiplexer*? How is it different from a *decoder*? Draw the circuit diagram for a 8:1 Multiplexer. [5]
- (b) Prove the Boolean expression using Boolean laws. Also, mention the law used at each step. [3]

$$F = (x' + z) + [(y' + z) \cdot (x' + y)]' = 1$$

- (c) Define *maxterms* and *minterms*. Find the maxterm and minterm when: [2]

$$P = 0, Q = 1, R = 1 \text{ and } S = 0$$

### SECTION – B

Answer *any two* questions.

*Each program should be written in such a way that it clearly depicts the logic of the problem.*

*This can be achieved by using mnemonic names and comments in the program.*

(Flowcharts and Algorithms are **not** required.)

**The programs must be written in Java.**

#### Question 7

A class **Palin** has been defined to check whether a positive number is a *Palindrome* number or not. [10]

*The number 'N' is palindrome if the original number and its reverse are same.*

Some of the members of the class are given below:

**Class name** : **Palin**

**Data members/instance variables:**

num : integer to store the number  
 revnum : integer to store the reverse of the number

**Methods/Member functions:**

Palin( ) : constructor to initialize data members with legal initial values  
 void accept( ) : to accept the number  
 int reverse(int y) : reverses the parameterized argument 'y' and stores it in 'revnum' using **recursive technique**  
 void check( ) : checks whether the number is a Palindrome by invoking the function **reverse( )** and display the result with an appropriate message

Specify the class **Palin** giving the details of the **constructor( )**, **void accept( )**, **int reverse( int )** and **void check( )**. Define the **main( )** function to create an object and call the functions accordingly to enable the task.

### Question 8

A class **Adder** has been defined to add any two accepted time.

[10]

Example: Time A - 6 hours 35 minutes

Time B - 7 hours 45 minutes

Their sum is - 14 hours 20 minutes ( where 60 minutes = 1 hour)

The details of the members of the class are given below:

**Class name** : **Adder**

**Data member/instance variable:**

a[ ] : integer array to hold two elements (hours and minutes)

**Member functions/methods:**

Adder( ) : constructor to assign 0 to the array elements

void readtime( ) : to enter the elements of the array

void addtime( Adder X, Adder Y) : adds the time of the two parameterized objects X and Y and stores the sum in the current calling object

void disptime( ) : displays the array elements with an appropriate message (i.e. hours = and minutes = )

Specify the class **Adder** giving details of the **constructor( )**, **void readtime( )**, **void addtime(Adder, Adder)** and **void disptime( )**. Define the **main( )** function to create objects and call the functions accordingly to enable the task.

### Question 9

A class **SwapSort** has been defined to perform string related operations on a word input. [10]  
Some of the members of the class are as follows:

**Class name** : **SwapSort**

**Data members/instance variables:**

wrđ : to store a word  
len : integer to store length of the word  
swapwrđ : to store the swapped word  
sortwrđ : to store the sorted word

**Member functions/methods:**

SwapSort( ) : default constructor to initialize data members with legal initial values  
void readword( ) : to accept a word in UPPER CASE  
void swapchar( ) : to interchange/swap the first and last characters of the word in 'wrđ' and stores the new word in 'swapwrđ'  
void sortword( ) : sorts the characters of the original word in alphabetical order and stores it in 'sortwrđ'  
void display( ) : displays the original word, swapped word and the sorted word

Specify the class **SwapSort**, giving the details of the **constructor( )**, **void readword( )**, **void swapchar( )**, **void sortword( )** and **void display( )**. Define the **main( )** function to create an object and call the functions accordingly to enable the task.

### SECTION – C

Answer *any two* questions.

*Each program should be written in such a way that it clearly depicts the logic of the problem stepwise.*

*This can be achieved by using comments in the program and mnemonic names or pseudo codes for algorithms. The programs must be written in Java and the algorithms must be written in general / standard form, wherever required / specified.*

(Flowcharts are **not** required.)

### Question 10

A *super class* **Product** has been defined to store the details of a product sold by a wholesaler to a retailer. Define a *sub class* **Sales** to compute the total amount paid by the retailer *with* or *without* *fine* along with *service tax*. [5]

Some of the members of both the classes are given below:

**Class name** : **Product**

**Data member/instance variable:**

name : stores the name of the product  
code : integer to store the product code  
amount : stores the total sale amount of the product (in decimals)

**Member functions/methods:**

Product(String n, int c, double p) : parameterized constructor to assign data members name=n, code=c and amount = p  
void show( ) : displays the details of the data members

**Class name:** **Sales**

**Data member/instance variable:**

day : stores number of days taken to pay the sale amount  
tax : to store the service tax (in decimals)  
totamt : to store the total amount (in decimals)

**Member functions/methods:**

Sales(...) : parameterized constructor to assign values to data members of both the classes  
void compute( ) : calculates the service tax @ 12.4% of the actual sale amount  
calculates the fine @ 2.5% of the actual sale amount **only** if the amount paid by the retailer to the wholesaler exceeds 30 days  
calculates the total amount paid by the retailer as (actual sale amount + service tax + fine)  
void show( ) : displays the data members of super class and the total amount

Assume that the super class **Product** has been defined. Using the **concept of inheritance**, specify the class **Sales** giving the details of the **constructor(...)**, **void compute( )** and **void show( )**.

**The super class, main function and algorithm need NOT be written.**

### Question 11

Queue is an entity which can hold a maximum of 100 integers. The queue enables the user to add integers from the rear and remove integers from the front. [5]

Define a class **Queue** with the following details:

**Class name** : **Queue**

#### **Data Members / instance**

##### **variables:**

|        |   |                                    |
|--------|---|------------------------------------|
| Que[ ] | : | array to hold the integer elements |
| size   | : | stores the size of the array       |
| front  | : | to point the index of the front    |
| rear   | : | to point the index of the rear     |

#### **Member functions:**

|                     |   |                                                                                                                    |
|---------------------|---|--------------------------------------------------------------------------------------------------------------------|
| Queue (int mm)      | : | constructor to initialize the data<br>size = mm, front = 0, rear = 0                                               |
| void addele(int v ) | : | to add integer from the rear if possible<br>else display the message " <b>Overflow</b> "                           |
| int delele( )       | : | returns elements from front if present,<br>otherwise displays the message<br>" <b>Underflow</b> " and return -9999 |
| void display ( )    | : | displays the array elements                                                                                        |

Specify the class **Queue** giving details of **ONLY** the functions **void addele(int)** and **int delele( )**. Assume that the other functions have been defined.

The main function and algorithm need NOT be written.

### Question 12

- (a) A linked list is formed from the objects of the class **Node**. The class structure of the Node is given below: [2]

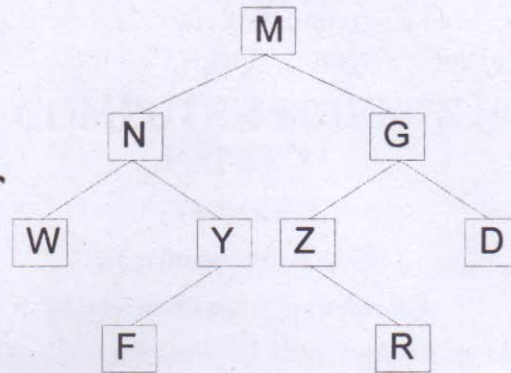
```
class Node
{
 int num;
 Node next;
}
```

Write an *Algorithm* OR a *Method* to count the nodes that contain only odd integers from an existing linked list and returns the count.

The method declaration is as follows:

**int CountOdd(Node startPtr)**

(b) Answer the following questions from the diagram of a Binary Tree given below:



- (i) Write the postorder traversal of the above tree structure. [1]
- (ii) State the level numbers of the nodes **N** and **R** if the root is at 0 (zero) level. [1]
- (iii) List the internal nodes of the right sub-tree. [1]