COMPUTER SCIENCE

PAPER 1

(THEORY)

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* ***seven*** *questions from Part-II, choosing* ***three*** *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

Answer **all** *questions.*

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

Question 1

(a) Simplify: $(A + C)\cdot(A + A\cdot D) + A\cdot C + C$ **[2]**

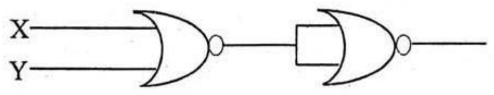
(b) Draw a logic circuit for $(A + B)\cdot(C + D)\cdot C$ **[2]**

(c) Verify the following proposition with the help of a truth table: **[2]**

$$P \vee (\sim P \wedge Q) = P \vee Q$$

(d) State De Morgan's law and verify it, using a truth table. **[2]**

(e) Answer the questions related to the circuit given below: **[2]**



(i) Give the output if, X=1 and Y=0

(ii) Name the basic gate represented by the above diagram.

This Paper consists of 9 printed pages and 1 blank page.

Question 13

(a) A linked list is formed from the objects of the class: **[4]**

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

Write an *Algorithm* **OR** a *Method* to print the sum of nodes that contains only odd integers of an existing linked list.

The method declaration is as follows:

void NodesCount(Nodes starPtr)

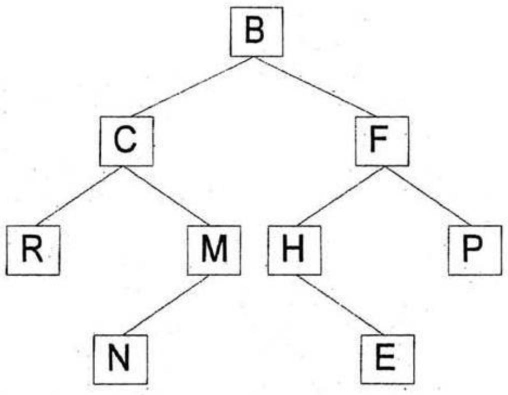
(b) (i) Give the meaning of the following common expression in Big O notation: **[1]**

$O(N)$

$O(N^2)$

(ii) List *any two* cases to analyse algorithm complexities. **[1]**

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



(i) Name the leaf nodes of the right sub-tree. **[1]**

(ii) Write postorder traversal of the left sub-tree of node B including itself. **[1]**

(iii) State the level number of nodes R and M when the root is at level 0. **[1]**

(iv) Name the internal nodes of the tree. **[1]**

Question 2

(a) Define *computational complexity*. Calculate the complexity using Big 'O' notation for the following code segment: **[2]**

```
for(int k=0;k<n;k++)
        s+=k;
```

(b) Convert the following infix notation into postfix form: **[2]**

X + (Y – Z) + ((W + E) * F) / J

(c) Differentiate between *this keyword* and *super keyword.* **[2]**

(d) The array D[-2…10][3…8] contains double type elements. If the base address is 4110, find the address of D[4][5], when the array is stored in **Column Major Wise**. **[2]**

(e) State *any two* characteristics of a Binary tree. **[2]**

Question 3

(a) The following function is a part of some class. Assume 'x' and 'y' are positive integers, greater than 0. Answer the given questions along with dry run / working.

```
void  someFun(int x, int y)
{
        if(x>1)
        {       if(x%y==0)
                {       System.out.print(y+" ");
                        someFun(x/y, y);
                }
                else
                        someFun(x, y+1);
        }
}
```

(i) What will be returned by **someFun(24,2)** ? **[2]**

(ii) What will be returned by **someFun(84,2)** ? **[2]**

(iii) State in one line what does the function **someFun( )** do, apart from recursion? **[1]**

(b) The following is a function of some class which checks if a positive integer is an Armstrong number by returning true or false. (*A number is said to be Armstrong if the sum of the cubes of all its digits is equal to the original number.*) The function does not use modulus (%) operator to extract digit. There are some places in the code marked by **?1?, ?2?, ?3?, ?4?, ?5?** which may be replaced by a statement / expression so that the function works properly.

```
boolean  ArmstrongNum( int N )
{
        int sum= ?1?;
        int num=N;
        while( num>0)
        {
           int f= num/10;
           int s =  ?2?;
           int digit = num−s;
           sum+=  ?3?;
           num = ?4?;
        }
        if(  ?5? )
           return true;
        else
           return false;
}
```

(i) What is the statement or expression at **?1?** **[1]**

(ii) What is the statement or expression at **?2?** **[1]**

(iii) What is the statement or expression at **?3?** **[1]**

(iv) What is the statement or expression at **?4?** **[1]**

(v) What is the statement or expression at **?5?** **[1]**

PART – II

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

SECTION - A

*Answer any **three** questions.*

Question 4

(a) Given the Boolean function **F(A, B, C, D) = π (0,1,2,3,5,7,8,9,10,11).**

(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:

P(A, B, C, D) = ABC'D' + A'BC'D' + A'BC'D + ABC'D + A'BCD + ABCD

(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 person is allowed to travel in a reserved coach of the train, if he/she satisfies the criteria given below: **[10]**

- The person has a valid reservation ticket and a valid ID proof.

OR

- The person does not have a valid reservation ticket, but holds a valid pass issued by the Railway department with a valid ID proof.

OR

- The person is a disabled person and holds a valid pass issued by the Railway department along with a valid ID proof.

The inputs are:

INPUTS	
R	The person has a valid reservation ticket.
P	The person holds a valid pass issued by the Railway department.
D	The person has a valid ID proof.
H	The person is a disabled person.

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

Output : **T** – Denotes allowed to travel (1 indicates yes and 0 indicates no in all the cases)

(a) Draw the truth table for the inputs and outputs given above and write the **POS** expression for **T(R, P, D, H)**. **[5]**

(b) Reduce **T(R, P, D, H)** using Karnaugh map. **[5]**

Draw the logic gate diagram for the reduced **POS** expression for **T(R, P, D, H)** using only **NOR** gates. You may use gates with two or more inputs. Assume that the variable and their complements are available as inputs.

Question 6

(a) Draw the truth table and logic gate diagram for an Octal to Binary encoder. **[4]**

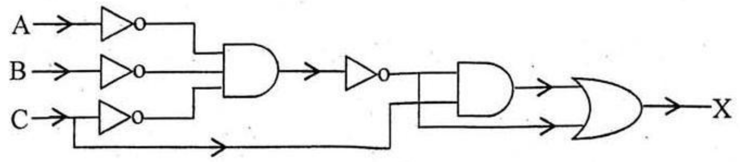
(b) What is a Multiplexer? State an application of a Multiplexer. Also, draw the logic diagram of a 4:1 Multiplexer. **[4]**

(c) Verify the following expression using Boolean laws. Also, mention the law used at each step of simplification. **[2]**

$$X{\cdot}Y{\cdot}Z + X{\cdot}Y'{\cdot}Z + X{\cdot}Y{\cdot}Z' = X \cdot (Y + Z)$$

Question 7

(a) Derive a Boolean expression for the logic circuit given below and reduce the derived expression, using Boolean laws: **[3]**



(b) What are universal gates? Construct a logic circuit using NAND gates only for the expression: $A \cdot (B + C)$ **[3]**

(c) Define *Half Adders*. Draw the circuit diagram and the truth table for a Half Adder. **[4]**

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 8

A class **Admission** contains the admission numbers of 100 students. Some of the data members / member functions are given below: **[10]**

Class name	:	**Admission**
Data member/instance variable:		
Adno[ ]	:	integer array to store admission numbers
Member functions/methods:		
Admission( )	:	constructor to initialize the array elements
void fillArray( )	:	to accept the elements of the array in ascending order
int binSearch(int l, int u, int v)	:	to search for a particular admission number (v) using **binary search** and **recursive technique** and returns 1 if found otherwise returns -1

Specify the class **Admission** giving details of the **constructor, void fillArray( )** and **int binSearch(int, int, int)** . Define the **main( )** function to create an object and call the functions accordingly to enable the task.

Question 9

A class **Merger** concatenates two positive integers that are greater than 0 and produces a new merged integer. **[10]**

Example: If the first number is **23** and the second is **764,** then the concatenated number will be **23764.**

Some of the members of the class are given below:

Class name	:	**Merger**
Data members/instance variables:		
n1	:	long integer to store first number
n2	:	long integer to store second number
mergNum	:	long integer to store the merged number
Member functions:		
Merger( )	:	constructor to initialize the data members
void readNum( )	:	to accept the values of the data members n1 and n2
void JoinNum( )	:	to concatenate the numbers n1 and n2 and store it in mergNum
void show( )	:	to display the original numbers and the merged number with appropriate messages

Specify the class **Merger,** giving the details of the **constructor, void readNum( ), void JoinNum( )** and **void show( )**. Define the **main( )** function to create an object and call the functions accordingly to enable the task.

Question 10

A class **TheString** accepts a string of a maximum of 100 characters with only one blank space between the words. **[10]**

Some of the members of the class are as follows:

Class name	:	**TheString**
Data member/instance variable:		
str	:	to store a string
len	:	integer to store the length of the string
wordcount	:	integer to store the number of words
cons	:	integer to store the number of consonants
Member functions/methods:		
TheString( )	:	default constructor to initialize the data members
TheString(String ds)	:	parameterized constructor to assign str=ds

void countFreq( )	:	to count the number of words and the number of consonants and store them in wordcount and cons respectively
void Display( )	:	to display the original string, along with the number of words and the number of consonants

Specify the class **TheString** giving the details of the **constructors, void countFreq( )** 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 11

WordPile is an entity which can hold maximum of 20 characters. The restriction is that a character can be added or removed from one end only.

Some of the members of classes are given below:

Class name	:	**WordPile**
Data members/instance variables:		
ch[ ]	:	character array to hold the character elements
capacity	:	integer variable to store the maximum capacity
top	:	to point to the index of the topmost element
Methods/Member functions:		
WordPile(int cap)	:	constructor to initialise the data member capacity = cap, top = -1 and create the WordPile
void pushChar(char v)	:	adds the character to the top of WordPile if possible, otherwise output a message "WordPile is full"
char popChar()	:	returns the deleted character from the top of the WordPile if possible, otherwise it returns '\\'

(a) Specify the class **WordPile** giving the details of the **constructor, void pushChar(char)** and **char popChar( )**. **The main function and algorithm need not be written.** **[8]**

(b) What is the name of the entity described above and state *one* of its applications. **[2]**

Question 12

A line on a plane can be represented by coordinates of the two-end points p1 and p2 as p1(x1, y1) and p2(x2, y2). **[10]**

A super class **Plane** is defined to represent a line and a sub class **Circle** to find the length of the radius and the area of circle by using the required data members of super class.
Some of the members of both the classes are given below:

Class name	:	**Plane**
Data members/instance variables:		
x1	:	to store the x-coordinate of the first end point
y1	:	to store the y-coordinate of the first end point
Member functions/methods:		
Plane(int nx, int ny)	:	parameterized constructor to assign the data members x1=nx and y1=ny
void Show( )	:	to display the coordinates
Class name	:	**Circle**
Data members/instance variables:		
x2	:	to store the x-coordinate of the second end point
y2	:	to store the y-coordinate of the second end point
radius	:	double variable to store the radius of the circle
area	:	double variable to store the area of the circle
Member functions / methods		
Circle(...)	:	parameterized constructor to assign values to data members of both the classes
void findRadius( )	:	to calculate the length of radius using the formula: $(\sqrt{(x2-x1)^2+(y2-y1)^2})/2$ assuming that x1, x2, y1, y2 are the coordinates of the two ends of the diameter of a circle
void findArea( )	:	to find the area of circle using formula: πr^2. The value of pie (π) is 22/7 or 3.14
void Show( )	:	to display both the coordinates along with the length of the radius and area of the of the circle

Specify the class **Plane** giving details of the **constructor** and **void Show( )**. Using the **concept of inheritance**, specify the class **Circle** giving details of the **constructor, void findRadius( ), void findArea( )** and **void Show( )**.
The main function and algorithm need not be written.

COMPUTER SCIENCE

Paper – 2

(PRACTICAL)

(Reading Time: 15 minutes)

(Planning Session AND Examination Session: Three Hours)

The total time to be spent on the Planning and the Examination Session is Three hours.

After completing the Planning Session, the candidate may begin with the Examination Session.

A maximum of 90 minutes is permitted to begin the Examination Session.

However, if candidates finish earlier, they are to be permitted to begin the Examination Session.

(Maximum Marks: 80)

As it is a practical examination the candidate is expected to do the following:

1. Write an algorithm for the selected problem. **[10]**
   (Algorithm should be expressed clearly using any standard scheme such as pseudo code or in steps which are simple enough to be obviously computable.)
2. Write a program in **JAVA** language. The program should follow the algorithm and should be logically and syntactically correct. **[20]**
3. Document the program using mnemonic names / comments, identifying and clearly describing the choice of data types and meaning of variables. **[10]**
4. Code / Type the program on the computer and get a printout (hard copy). Typically, this should be a program that compiles and runs correctly. **[10]**
5. Test run the program on the computer using the given sample data and get a printout of the output in the format specified in the problem. **[10]**
6. Viva-Voce on the **Selected Problem.** **[20]**

This Paper consists of 4 printed pages.

Solve any ***one*** *of the following Problems:*

Question 1

Given two positive numbers M and N, such that M is between 100 and 10000 and N is less than 100. Find the smallest integer that is greater than M and whose digits add up to N. For example, if M = 100 and N = 11, then the smallest integer greater than 100 whose digits add up to 11 is 119.

Write a program to accept the numbers M and N from the user and print the smallest required number whose sum of all its digits is equal to N. Also, print the total number of digits present in the required number. The program should check for the validity of the inputs and display an appropriate message for an invalid input.

Test your program with the sample data and some random data:

Example 1

INPUT: M = 100

N = 11

OUTPUT: The required number = 119
Total number of digits = 3

Example 2

INPUT: M = 1500

N = 25

OUTPUT: The required number = 1699
Total number of digits = 4

Example 3

INPUT: M = 99

N = 11

OUTPUT: INVALID INPUT

Example 4

INPUT: M = 112

N = 130

OUTPUT: INVALID INPUT

Question 2

Write a program to declare a square matrix A[ ][ ] of order MxM where 'M' is the number of rows and the number of columns, such that M must be greater than 2 and less than I 0. Accept the value of M as user input. Display an appropriate message for an invalid input. Allow the user to input integers into this matrix. Perform the following tasks:

(a) Display the original matrix.

(b) Rotate the matrix 90° clockwise as shown below:

```
        Original matrix          Rotated matrix
          1  2  3                  7  4  1
          4  5  6                  8  5  2
          7  8  9                  9  6  3
```

(c) Find the sum of the elements of the four comers of the matrix.

Test your program with the sample data and some random data:

Example 1

```
INPUT :      M = 3
             3    4    9
             2    5    8
             1    6    7
OUTPUT :
ORIGINAL MATRIX
             3    4    9
             2    5    8
             1    6    7
MATRIX AFTER ROTATION
             1    2    3
             6    5    4
             7    8    9
Sum of the corner elements = 20
```

Example 2

```
INPUT :      M = 4
             1    2    4    9
             2    5    8    3
             1    6    7    4
             3    7    6    5
OUTPUT :
ORIGINAL MATRIX
             1    2    4    9
             2    5    8    3
             1    6    7    4
             3    7    6    5
```

MATRIX AFTER ROTATION

```
3   1   2   1
7   6   5   2
6   7   8   4
5   4   3   9
```

Sum of the corner elements = 18

Example 3

INPUT : M = 14
OUTPUT : SIZE OUT OF RANGE

Question 3

Write a program to accept a sentence which may be terminated by either '.' or '?' only. The words are to be separated by a single blank space. Print an error message if the input does not terminate with '.' or '?'. You can assume that no word in the sentence exceeds 15 characters, so that you get a proper formatted output.

Perform the following tasks:

(i) Convert the first letter of each word to uppercase.

(ii) Find the number of vowels and consonants in each word and display them with proper headings along with the words.

Test your program with the following inputs.

Example 1

INPUT : Intelligence plus character is education.

OUTPUT :

```
Intelligence Plus Character Is Education

Word          Vowels     Consonants
Intelligence    5            7
Plus            1            3
Character       3            6
Is              1            1
Education       5            4
```

Example 2

INPUT : God is great.

OUTPUT :

```
God Is Great

Word          Vowels     Consonants
God             1            2
Is              1            1
Great           2            3
```

Example 3

INPUT: All the best!

OUTPUT: Invalid Input.