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 *Commutative law* and prove it with the help of a truth table. [1]

(b) Convert the following expression into its canonical POS form: [1]

$$F(X, Y, Z) = (X+Y') \cdot (Y'+Z)$$

(c) Find the dual of: [1]

$$(A'+B) \cdot (1+B') = A'+B$$

(d) Verify the following proposition with the help of a truth table: [1]

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

(e) If $F(A, B, C) = A'(BC' + B'C)$, then find F′ [1]

Question 2

(a) What are *Wrapper classes?* Give *any two* examples. [2]

(b) A matrix A[m][m] is stored in the memory with each element requiring 4 bytes of storage. If the base address at A[1][1] is 1500 and the address of A[4][5] is 1608, determine the order of the matrix when it is stored in **Column Major Wise**. [2]

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

Turn over

(c) Convert the following *infix notation* to *postfix* form: [2]

A + (B − C ∗ (D / E) ∗ F)

(d) Define *Big 'O' notation*. State the *two* factors which determine the complexity of an algorithm. [2]

(e) What is *exceptional handling?* Also, state the purpose of *finally* block in a try catch statement. [2]

Question 3

The following is a function of some class which checks if a positive integer is a Palindrome number by returning true or false. (*A number is said to be palindrome if the reverse of the number 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  PalindromeNum( int N )
{
        int rev= ?1?;
        int num=N;
        while( num>0)
        {
           int f= num/10;
           int s =  ?2?;
           int digit = num−?3?;
           rev=  ?4?  + digit;
           num /= ?5?;
        }
        if(  rev= =N )
           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 (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) = Σ (0,2,4,8,9,10,12,13).**

(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(A, B, C, D) = π(3,4,5,6,7,10,11,14,15).**

(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 training institute intends to give scholarships to its students as per the criteria given below : **[5]**

- The student has excellent academic record but is financially weak.

OR

- The student does not have an excellent academic record and belongs to a backward class.

OR

- The student does not have an excellent academic record and is physically impaired.

The inputs are:

INPUTS	
A	Has excellent academic record
F	Financially sound
C	Belongs to a backward class
I	Is physically impaired

(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 **SOP** expression for **X(A,F,C,I)**.

$(A+\overline{C}+\overline{D})\bullet(A+\overline{B}).(\overline{A}+\overline{C})$

$B\overline{C}\overline{D}+A\overline{C}D+\overline{B}\overline{D}$

(b) Using the truth table, state whether the following proposition is a *tautology*, *contingency* or a *contradiction*: [3]

$$\sim(A \wedge B) V (\sim A \Rightarrow B)$$

(c) Simplify the following expression, using Boolean laws: [2]

$$A \bullet (A' + B) \bullet C \bullet (A + B)$$

Question 6

(a) What is an *Encoder?* Draw the Encoder circuit to convert A-F hexadecimal numbers to binary. State an application of a Multiplexer. [5]

(b) Differentiate between *Half Adder* and *Full Adder*. Draw the logic circuit diagram for a Full Adder. [3]

(c) Using only NAND gates, draw the logic circuit diagram for $A' + B$. [2]

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

Design a class **Perfect** to check if a given number is a perfect number or not. [A number is said to be perfect if sum of the factors of the number excluding itself is equal to the original number] [10]

Example : 6 = 1 + 2 + 3 (where 1, 2 and 3 are factors of 6, excluding itself)

Some of the members of the class are given below:

Class name	:	**Perfect**
Data members/instance variables:		
num	:	to store the number
Methods/Member functions:		
Perfect (int nn)	:	parameterized constructor to initialize the data member num=nn
int sum_of_factors(int i)	:	returns the sum of the factors of the number(num), excluding itself, using **recursive technique**
void check( )	:	checks whether the given number is perfect by invoking the function *sum_of_factors( )* and displays the result with an appropriate message

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

Question 8

Two matrices are said to be equal if they have the same dimension and their corresponding elements are equal. [10]

For example the two matrices A and B given below are equal:

Matrix A

1	2	3
2	4	5
3	5	6

Matrix B

1	2	3
2	4	5
3	5	6

Design a class **EqMat** to check if two matrices are equal or not. Assume that the two matrices have the same dimension.

Some of the members of the class are given below:

Class name : **EqMat**

Data members/instance variables:

a[ ][ ] : to store integer elements

m : to store the number of rows

n : to store the number of columns

Member functions/methods:

EqMat(int mm, int nn) : parameterised constructor to initialise the data members m = mm and n = nn

void readarray( ) : to enter elements in the array

int check(EqMat P, EqMat Q) : checks if the parameterized objects P and Q are equal and returns 1 if true, otherwise returns 0

void print( ) : displays the array elements

Define the class **EqMat** giving details of the **constructor( ), void readarray( ), int check(EqMat, EqMat)** and **void print( )**. Define the **main( )** function to create objects and call the functions accordingly to enable the task.

Question 9

A class **Capital** has been defined to check whether a sentence has words beginning with a capital letter or not. **[10]**

Some of the members of the class are given below:

Class name	:	**Capital**
Data member/instance variable:		
sent	:	to store a sentence
freq	:	stores the frequency of words beginning with a capital letter
Member functions/methods:		
Capital( )	:	default constructor
void input( )	:	to accept the sentence
boolean isCap(String w)	:	checks and returns true if word begins with a capital letter, otherwise returns false
void display( )	:	displays the sentence along with the frequency of the words beginning with a capital letter

Specify the class **Capital**, giving the details of the **constructor( ), void input( ), boolean isCap(String)** 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 **Number** is defined to calculate the factorial of a number. Define a sub class **Series** to find the sum of the series S = 1! + 2! + 3! + 4!+…………......+n! **[5]**

The details of the members of both the classes are given below:

Class name : **Number**

Data member/instance variable:

n : to store an integer number

Member functions/methods:

Number(int nn) : parameterized constructor to initialize the data member n=nn

int factorial(int a) : returns the factorial of a number (factorial of n = 1×2×3× ……..×n)

void display( ) : displays the data members

Class name: **Series**

Data member/instance variable:

sum : to store the sum of the series

Member functions/methods:

Series(…) : parameterized constructor to initialize the data members of both the classes

void calsum( ) : calculates the sum of the given series

void display( ) : displays the data members of both the classes

<u>*Assume that the super class **Number** has been defined*</u>. Using the **concept of inheritance**, specify the class **Series** giving the details of the **constructor(…),void calsum( )** and **void display( ).**

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

Question 11

Register is an entity which can hold a maximum of 100 names. The register enables the user to add and remove names from the top most end only.

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

Class name : **Register**

Data members / instance variables:

stud[ ] : array to store the names of the students

cap : stores the maximum capacity of the array

top : to point the index of the top end

Member functions:

Register (int max) : constructor to initialize the data member cap = max, top = −1 and create the string array

void push(String n) : to add names in the register at the top location if possible, otherwise display the message "OVERFLOW"

String pop( ) : removes and returns the names from the top most location of the register if any, else returns "$$"

void display( ) : displays all the names in the register

(a) Specify the class **Register** giving details of the functions **void push(String)** and **String pop( )**. Assume that the other functions have been defined. **[4]**

The main function and algorithm need NOT be written.

(b) Name the entity used in the above data structure arrangement. **[1]**

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]**

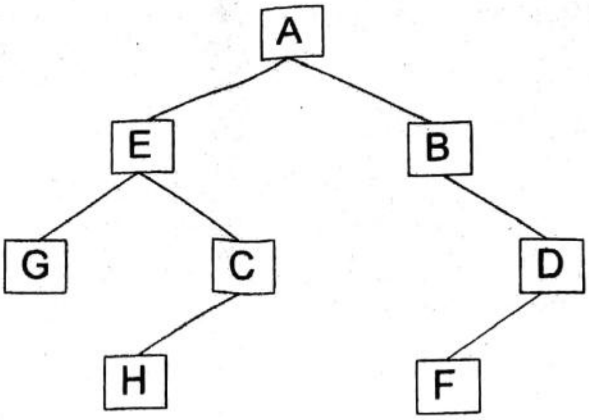
```
class   Node
{
        int n;
        Node   link;
}
```

Write an *Algorithm* **OR** a *Method* to search for a number from an existing linked list.

The method declaration is as follows:

```
void  FindNode( Node  str, int b  )
```

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



(i) Write the inorder traversal of the above tree structure. [1]

(ii) State the height of the tree, if the root is at level **0** (zero). [1]

(iii) List the leaf nodes of the tree. [1]

COMPUTER SCIENCE

Paper – 2

(PRACTICAL)

(Maximum Marks: 30)

(Time allowed: Three hours)

(Candidates are allowed additional 15 minutes for only reading the paper.

They must NOT start writing during this time.)

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

Planning session: 90 minutes

Examination session : 90 minutes

Note: Candidates are to be permitted to proceed to the Examination Session only after 90 minutes of the Planning session are over.

---

*This paper consists of **three** problems from which candidates are required to attempt **any one** problem.*

Candidates are expected to do the following:

1. Write an algorithm for the selected problem. (Algorithm should be expressed clearly using any standard scheme such as pseudo code or in steps which are simple enough to be obviously computable.) [3]
2. Write a program in **JAVA** language. The program should follow the algorithm and should be logically and syntactically correct. [5]
3. Document the program using mnemonic names / comments, identifying and clearly describing the choice of data types and meaning of variables. [2]
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. [2]
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. [5]
6. Viva-Voce on the **Selected Problem**. [3]

In addition to the above, the practical file of the candidate containing the practical work related to programming assignments done during the year is to be evaluated as follows:

- Programming assignments done throughout the year (by the teacher) [5]
- Programming assignments done throughout the year (by the Visiting Examiner) [5]

This Paper consists of 5 printed pages and 1 blank page.

Solve any one of the following Problems.

Question 1

A Goldbach number is a positive even integer that can be expressed as the sum of two odd primes.

Note: ***All even integer numbers greater than 4 are Goldbach numbers.***

Example: 6 = 3 + 3

10 = 3 + 7
10 = 5 + 5

Hence, 6 has one odd prime pair 3 and 3. Similarly, 10 has two odd prime pairs, i.e. 3 and 7, 5 and 5.

Write a program to accept an even integer 'N' where N > 9 and N < 50. Find all the odd prime pairs whose sum is equal to the number 'N'.

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

Example 1:

INPUT: N = 14

```
OUTPUT:   PRIME PAIRS ARE:   3,  11
                             7,   7
```

Example 2:

INPUT: N = 30

```
OUTPUT:   PRIME PAIRS ARE:   7,  23
                            11,  19
                            13,  17
```

Example 3:

INPUT: N = 17

OUTPUT: INVALID INPUT. NUMBER IS ODD.

Example 4:

INPUT: N = 126

OUTPUT: INVALID INPUT. NUMBER OUT OF RANGE.

Question 2

Write a program to declare a matrix A[ ] [ ] of order (M×N) where 'M' is the number of rows and 'N' is the number of columns such that the values of both 'M' and 'N' must be greater than 2 and less than 10. Allow the user to input integers into this matrix. Perform the following tasks on the matrix:

(a) Display the original matrix.

(b) Sort each row of the matrix in ascending order using any standard sorting technique.

(c) Display the changed matrix after sorting each row.

Test your program for the following data and some random data:

Example 1:

INPUT:

```
                M = 4
                N = 3

 ENTER ELEMENTS OF MATRIX
                11  -2   3
                5   16   7
                9    0   4
                3    1   8
```

OUTPUT:

```
 ORIGINAL MATRIX
                11  -2   3
                5   16   7
                9    0   4
                3    1   8

 MATRIX AFTER SORTING ROWS
                -2   3   11
                5    7   16
                0    4   9
                1    3   8
```

Example 2:

INPUT:

```
                M = 3
                N = 3

 ENTER ELEMENTS OF MATRIX
                22   5   19
                7    36  12
                9    13  6
```

OUTPUT:

```
ORIGINAL MATRIX
                    22   5   19
                    7    36  12
                    9    13  6


MATRIX AFTER SORTING ROWS
                    5   19  22
                    7   12  36
                    6   9   13
```

Example 3:

INPUT: M = 11
N = 5

OUTPUT:

```
MATRIX SIZE OUT OF RANGE
```

Question 3

The names of the teams participating in a competition should be displayed on a banner vertically, to accommodate as many teams as possible in a single banner. Design a program to accept the names of N teams, where 2 < N < 9 and display them in vertical order, side by side with a horizontal tab (i.e. eight spaces).

Test your program for the following data and some random data:

Example 1:

INPUT: N = 3
Team 1: Emus
Team 2: Road Rols
Team 3: Coyote

OUTPUT:

```
E       R       C
m       o       o
u       a       y
s       d       o
                t
        R       e
        o
        l
        s
```

Example 2:

INPUT:

```
N = 4
Team 1:  Royal
Team 2:  Mars
Team 3:  De Rose
Team 4:  Kings
```

OUTPUT:

```
R     M     D     K
o     a     e     i
y     r           n
a     s     R     g
l           o     s
            s
            e
```

Example 3:

INPUT: N = 10

OUTPUT: INVALID INPUT