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.)

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*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 properties of zero in Boolean algebra.   **[1]**

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

$$F(P,Q,R) = P + (Q' \cdot R)$$

(c)   Find the dual of: $(A' + 0) \cdot (B' + 1) = A'$ **[1]**

(d)   State whether the following proposition is a tautology, contradiction or a contingency: **[1]**

$$F = (P => Q) \lor (Q => \sim P)$$

(e)   Study the diagram given below and answer the questions that follow: **[1]**
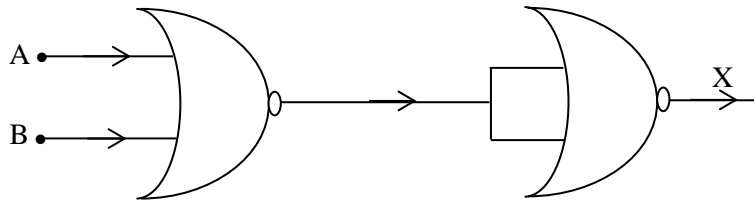
(i)   Name the basic gate which is represented by the diagram.

(ii)   What will be the value of X when A=1 and B=0 ?

This Paper consists of 8 printed pages.

Question 2

(a)   State the difference between a *Binary Tree structure* and a *single Linked List*.   **[2]**

(b)   A matrix B[10][20] is stored in the memory with each element requiring 2 bytes of storage. If the base address at B[2][1] is 2140, find the address of B[5][4] when the matrix is stored in **Column Major Wise**.   **[2]**

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

$$(X + Y) / (Z * W / V)$$

(d)   State the best case and the worst case complexity for bubble sort algorithm.   **[2]**

(e)   What is the significance of the keyword '**new**' in Java? Mention the areas where it is used.   **[2]**

Question 3

The following function **check( )** is a part of some class. What will the function check( ) return when the value of (i) **n=25** and (ii) **n=10.** Show the dry run/ working.   **[5]**

```
    int check(int n)
 {   if(n<=1)
         return 1;
      if( n%2==0)
         return 1 + check(n/2);
    else
        return 1 + check(n/2 + 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, 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13,14).**

(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, 6, 9, 11, 12, 13, 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)   Draw the logic circuit diagram for an octal to binary encoder and explain its working when a particular digit is pressed. Also, state the difference between *encoders* and *decoders*. **[5]**

(b)   Draw the circuit of a two input XOR gate with the help of NOR gates. **[3]**

(c)   Convert the following expression to its cardinal SOP form: **[2]**

$$F(P,Q,R) = P'Q'R + P'QR + PQ'R' + PQR'$$

Question 6

(a)   A company intends to develop a device to show the high status power load for a household invertor depending on the criteria given below: **[5]**

-     If Air conditioner and Geyser are on

        OR

-     If Air conditioner is off, but Geyser and Refrigerator are on

        OR

-     If Geyser is off, but Air conditioner and Water purifier are on

        OR

-     When all are on

The inputs are:

INPUTS	
A	Air conditioner is on
G	Geyser is on
R	Refrigerator is on
W	Water purifier is on

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

Output : **X** [1 indicates high power, 0 indicates low power for all cases]

Draw the truth table for the inputs and outputs given above and write the **SOP** expression for **X(A,G,R,W)**.

(b)   Draw the truth table and derive an SOP expression for *sum* and *carry* for a full adder. Also, draw the logic circuit for the *carry* of a full adder. **[3]**

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

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

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*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 **Convert** to find the date and the month from a given day number for a particular year.   **[10]**

Example: If day number is 64 and the year is 2020, then the corresponding date would be:

March 4, 2020 i.e. (31 + 29 + 4 = 64)

Some of the members of the class are given below:

Class name   :   **Convert**

Data members/instance variables:

n	:	integer to store the day number
d	:	integer to store the day of the month (date)
m		integer to store the month
y	:	integer to store the year

Methods/Member functions:

Convert ( )	:	constructor to initialize the data members with legal initial values
void accept( )	:	to accept the day number and the year
void day_to_date( )	:	converts the day number to its corresponding date for a particular year and stores the date in 'd' and the month in 'm'
void display( )	:	displays the month name, date and year

Specify the class **Convert** giving details of the **constructor( )**, **void accept( )**, **void day_to_date( )** and **void display( )**. Define a **main( )** function to create an object and call the functions accordingly to enable the task.

Question 8

Design a class **BinSearch** to search for a particular value in an array.   **[10]**

Some of the members of the class are given below:

Class name   :   **BinSearch**

Data members/instance variables:

arr[ ]	:	to store integer elements
n	:	integer to store the size of the array

Member functions/methods:

BinSearch(int nn)	:	parameterized constructor to initialize n=nn

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void fillarray( )	:	to enter elements in the array
void sort( )	:	sorts the array elements in ascending order using any standard sorting technique
int bin_search(int l,int u,int v)	:	searches for the value 'v' using **binary search** and **recursive technique** and returns its location if found otherwise returns -1

Define the class **BinSearch** giving details of the **constructor( ), void fillarray( ), void sort( )** and **int bin_search(int,int,int)**. Define the **main( )** function to create an object and call the functions accordingly to enable the task.

Question 9

A class **Mix** has been defined to mix two words, character by character, in the following manner: **[10]**

The first character of the first word is followed by the first character of the second word and so on. If the words are of different length, the remaining characters of the longer word are put at the end.

Example: If the First word is "JUMP" and the second word is "STROLL", then the required word will be "JSUTMRPOLL"

Some of the members of the class are given below:

Class name	:	**Mix**

Data member/instance variable:

wrd	:	to store a word
len	:	to store the length of the word

Member functions/methods:

Mix( )	:	default constructor to initialize the data members with legal initial values
void feedword( )	:	to accept the word in UPPER case
void mix_word(Mix P, Mix Q)	:	mixes the words of objects P and Q as stated above and stores the resultant word in the current object
void display( )	:	displays the word

Specify the class **Mix** giving the details of the **constructor( ), void feedword( ), void mix_word(Mix, Mix)** and **void display( )**. Define the **main( )** function to create objects and call the functions accordingly to enable the task.

*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 Circular queue is a linear data structure which works on the principle of FIFO, enables the user to enter data from the rear end and remove data from the front end with the rear end connected to the front end to form a circular pattern. Define a class **CirQueue** with the following details:

Class name   :   **CirQueue**

Data members / instance variables:

cq[ ]	:	array to store the integers
cap	:	stores the maximum capacity of the array
front	:	to point the index of the front end
rear	:	to point the index of the rear end

Member functions:

CirQueue (int max)	:	constructor to initialize the data member cap=max, front=0 and rear=0
void push(int n)	:	to add integer in the queue from the rear end if possible, otherwise display the message "QUEUE IS FULL"
int pop( )	:	removes and returns the integer from the front end of the queue if any, else returns -9999
void show( )	:	displays the queue elements

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

      The main function and algorithm need NOT be written.

(b)   How is a *linear queue structure* different from a *circular queue structure*?   **[1]**

Question 11

An interface **Data** is defined with a data member and a method volume( ) which returns the **[5]** volume of the implementing shape. A super class **Base** has been defined to contain the radius of a geometrical shape. Define a sub class **CalVol** which uses the properties of the interface **Data** and the class **Base** and calculates the volume of a cylinder.

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

Interface name	:	**Data**

Data member:

double pi	:	initialize pi = 3.142

Member functions/methods:

double volume( )	:	

Class name:		**Base**

Data member/instance variable:

rad	:	to store the radius in decimal

Member functions/methods:

Base(…)	:	parameterized constructor to initialize the data member
void show( )	:	displays the radius with an appropriate message

Class name:		**CalVol**

Data member/instance variable:

ht	:	to store the height in decimal

Member functions/methods:

CalVol(…)	:	parameterized constructor to initialize the data members of both the classes
double volume( )	:	calculates the volume of a sphere by using the formula (pi x radius^2 x height)
void show( )	:	displays the data members of both the classes and the volume of the sphere with appropriate message

*Assume that the interface **Data** and the super class **Base** has been defined.* Using the **concept of inheritance**, specify the class **CalVol** giving the details of the **constructor(…)**, **double volume( )** and **void show( )**.

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

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1220-868A   **Turn over**

Question 12

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

              class   Node
              {
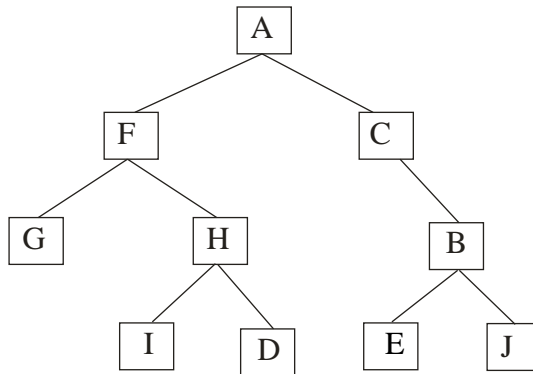   **int n;**
                      Node next;
              }

      Write an *Algorithm* **OR** a *Method* to find the product of the integer numbers from an
      existing linked list.

      The method declaration is as follows:

              void Product_Node(Node str)

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

      (i)   Write the *post-order* traversal of the left subtree of the above structure.   **[1]**

      (ii)   State the degree of the Nodes E and H.   **[1]**

      (iii) Mention the external nodes of the right subtree.   **[1]**