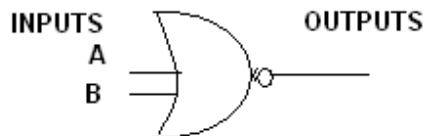


**ISC 2009  
COMPUTER SCIENCE PAPER 1  
THEORY  
PART I**

Answer all questions in this part

**Question 1.**

- a) Obtain the truth table to verify the following expression:  $X(Y+Z) = XY + XZ$ . Also name the law stated above.
- b) Answer the following questions related to the gate given below:



- i) What is the output of the above gate if input  $A=0$ ,  $B=1$
  - ii) What are the values of the inputs if output is 1?
- c) Given  $F = A + (B=C) \cdot (D'+E)$ . Find  $F'$  and show the relevant working in steps.
  - d) State the dual for the following expression and also draw the logic gate diagram for the dual expression obtained using NOR gate only.  
 $P = A \cdot B + C \cdot D$
  - e) For the given truth table where A,B,C are inputs and X is the output,

| A | B | C | X |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |

Write

- i) Canonical Sum of Product expression
- ii) Canonical Product of Sum expression

**[ 2 x 5 = 10 ]**

**Question 2.**

- a) State a difference between linear and non linear data structure. Give one example of each.
- b) Convert the following infix expression to its postfix form:-  
 $((P*Q) / (R/S +T)) + U$
- c) Simplify the following expression by using the Boolean laws. Show the working in steps and also mention the laws used.:  
 $X'Y'Z' + X'Y'Z + X'YZ + X'YZ' + XY'Z + XY'Z'$

- d) Each element of an array A[20][10] requires 2 bytes of storage. If the address of A[6][8] is 4000, find the base address at A[0][0] when the array is stored row major wise.
- e) Define inheritance. How is it useful in programming?

[ 2 x 5 = 10]

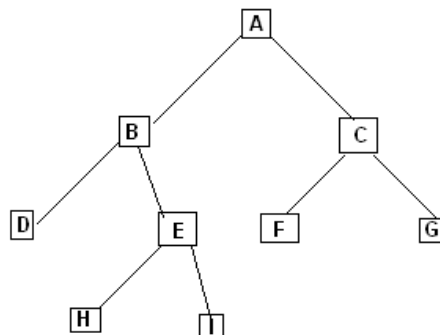
**Question 3.**

- a) The following function trial() and perform() are a part of some class. Answer the following parts given below. Show the dry run/working.

```
int trial()
{
    if(n==1)
        return 2;
    else if(n==2)
        return 3;
    else
        return trial(n-2) + trial(n-1);
}
```

```
void perform(int p)
{
    int x;
    for(int i=1;i<=p;i++)
    {
        x=trial(i);
        System.out.print(x+" ");
    }
}
```

- i) What will the function trial() return when the value of n is 4? [ 2 ]
- ii) What will be the output of the function perform() when the value of p is 5? [ 2 ]
- iii) In one line state what the function trial() is doing, apart from recursion? [ 1 ]
- b) Answer the following from the diagram of a binary tree given below:



- i) Root of the tree.
- ii) External nodes of the tree.
- iii) List the nodes in the tree using inorder traversal.
- iv) Left subtree
- v) Height of the tree

[ 1 X 5 = 5 ]

**Part II**  
**Section A**

Answer any three questions

**Question 4.**

a)  $F(P,Q,R,S) = P'Q'RS' + P'QRS' + PQ'R'S + PQ'RS' + PQ'RS + PQR'S + PQRS' + PQRS$

Use Karnaugh map to reduce the given function F using the SOP form. Draw a logic gate diagram for the reduced SOP form. You may use gates with more than two inputs. Assume that the variables and their complements are available as inputs.

b)  $F(A,B,C,D) = \pi(0,1,2,3,5,7,9,13)$

Use Karnaugh map to reduce the given function F using the POS form. Draw a logic gate diagram for the reduced POS form. You may use gates with more than two inputs. Assume that the variables and their complements are available as inputs.

[ 5 x 2 = 10 ]

**Question 5.**

A provisional store announces a special discount on all its products as a festival offer only to those who satisfy any one of the following conditions:

- If he/she is an employee of the store and has a service of more than ten years  
OR
- If he/she is a regular customer of the store whose age is less than 65 years and is not an employee of the store  
OR
- If he/she is a senior citizen but not a regular customer of the store

The inputs are:

- E : Employee of the store
- R : Regular customer of the store
- S : Service of the employee is more than 10 years
- C : Senior citizen of 65 years or above

Output

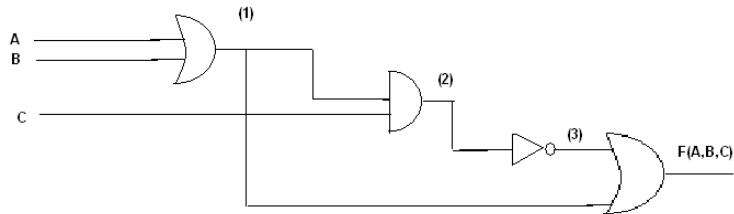
- X : Denotes eligible for discount [ 1 indicates YES and 0 indicates NO in all cases ]

- a) Draw the truth table for the inputs and outputs given above and write the SOP expression for  $X(E,R,S,C)$
- b) Reduce  $X(E,R,S,C)$  using Karnaugh's map.  
Draw the logic gate diagram for the reduced SOP expression for  $X(E,R,S,C)$  using AND , OR gates . You may use gates with more than 2 inputs. Assume that the variables and their complements are available as inputs.

[ 5 x 2 = 10 ]

**Question 6.**

- a) Draw a truth table representing a 2 input XNOR gate and derive its SOP expression along with its logic gate diagram. [ 3 ]
- b) Simplify the following expression and convert it to its canonical POS form:  
 $(X.Y+Z)(Y+Z'.X)$  [ 3 ]
- c) From the logic circuit diagram given below, name the parts (1), (2), (3) and finally derive the Boolean expression and simplify it:



[4]

**Question 7.**

- a) Prove that the complement of  $A(A+B).B(B+C')$  is a universal gate. [ 2 ]
- b) Minimise the following expression. At each step state clearly the law used.  
 $Y=(A+B').(B+CD)'$  [ 3 ]
- c) Draw the truth table and logic circuit diagram for a decimal to binary encoder. [ 5 ]

**Question 8.**

- a) State a difference between multiplexers and decoders. Also state a use of each. [ 2 ]
- b) Verify the following Boolean expression with the help of truth table. [ 3 ]  
 $A \oplus (B \odot C) = A \odot (B \oplus C)$  [ 5 ]
- c) Write the SOP expression, truth table and the logic circuit of full adder. [ 5 ]

## Section B

Answer any 4 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 C++/Java**

### Question 9.

A magic number is a number in which the eventual sum of digits of the number is equal to 1. For

example,  $172 = 1 + 7 + 2 = 10$

$10 = 1 + 0 = 1$

Then 172 is a magic number.

Design a class Magic to check if a given number is a magic number. Some of the members of the class are given below:

|                        |   |   |
|------------------------|---|---|
| Class name             | : | Magic   |
| Data members           |   |   |
| n                      | : | stores the number   |
| Member functions       |   |   |
| Magic()                | : | constructor to assign 0 to n  |
| void getnum(intnn)     | : | to assign the parameter value to the number, n=nn   |
| int Sum_of_digits(int) | : | return the sum of the digits of number  |
| void ismagic()         | : | checks if the given number is a magic number by calling the function Sum_of_digits(int) and displays appropriate message. |

Specify the class Magic by giving details of the constructor, void getnum(int), intSum\_of\_digits(int) and void ismagic(). You need not write the main function.

[ 10 ]

### Question 10.

A transpose of an array is obtained by interchanging the elements of rows and columns. A class Transarray contains a two dimensional integer array of order [ m x n]. The maximum value possible for both 'm' and 'n' is 20. Design a class Transarray to find the transpose of a given matrix. The details of the members of the class are given below:

|                  |   |   |
|------------------|---|---|
| Class name       | : | Trasarray                               |
| Data members     |   |   |
| arr[][]          | : | stores the matrix elements              |
| m                | : | integer to store the number of rows.    |
| n                | : | integer to store the number of columns. |
| Member functions |   |   |
| Transarray()     | : | default constructor.                    |

|                              |   |  |
|------------------------------|---|--|
| Transarray(intmm,intnn)      | : | to initialize the size of the matrix, m=mm,n=nn. |
| voidfillarray()              | : | to enter elements into the matrix.               |
| void transpose(Transarray A) | : | to find the transpose of a given matrix.         |
| voiddisaparray()             | : | displays the array in a matrix form.             |

Specify the class Transarray giving details of the constructors, void fillarray(), void transpose(Transarray) and void disaparray(). You need not write the main function.

[ 10 ]

### Question 11.

A library issues books on a rental basis at a 2% charge on the cost price of the book per day. As per the rules of the library, a book can be retained for 7 days without any fine. If the book is returned after 7 days, a fine will also be charged for the excess days as per the chart given below:

| Number of excess days | Fine per day |
|-----------------------|--------------|
| 1 to 5                | 2.00         |
| 6 to 10               | 3.00         |
| Above 10 days         | 5.00         |

Design a class Library and another class Compute to perform the task. The details of the 2 classes are given below:

|                  |   |  |
|------------------|---|--|
| Class name       | : | Library  |
| Data members     |   |  |
| name             | : | name of the book   |
| author           | : | author of the book   |
| p                | : | price of the book in decimals  |
| Member functions |   |  |
| Library(...)     | : | parameterized constructor to assign values to data members.                                |
| void show()      | : | display the book details   |
| class name       | : | Compute  |
| Data members     |   |  |
| d                | : | number of days taken in returning the book.  |
| f                | : | to store the fine.   |
| Member functions |   |  |
| Compute(...)     | : | parameterized constructor to assign values to data Members of both classes.                |
| void fine()      | : | calculate the fine for excess days.  |
| void display()   | : | displays the book details along with the number of days, fine and total amount to be paid. |

Total amount is calculated as:

$(2\% \text{ of price of book } * \text{ total no. of days}) + \text{fine}$

Specify the class Library giving details of the constructors and void show(). Using the concept of inheritance, specify the class Compute giving details of the constructor, void fine() and the void display() function. You need not write the main function.

[ 10 ]

### Question 12.

A class PrimeFac contains an array of 50 integers. Some of the members of the class are given below:

|                  |   |   |
|------------------|---|---|
| Class name       | : | PrimeFac  |
| Data members     |   |   |
| num[]            | : | array to store integers.  |
| freq[]           | : | array to store the frequency of prime factors of numbers.   |
| Member functions |   |   |
| PrimeFac()       | : | constructor to initialize array elements to 0.  |
| void enter()     | : | to enter values into array num[]  |
| void frefac()    | : | to determine the frequency of prime factors of the numbers stored in num[] and assign it to freq[]. |
| void disp()      | : | to display both the arrays.   |

Specify the class PrimeFac giving details of the constructor, void enter(), void frefac() and void disp(). You need not write the main function.

[ 10 ]

### Question 13.

Class Binary contains an array of n integers ( $n \leq 100$ ) that are already arranged in ascending order. The subscripts of the array elements vary from 0 to n-1. The data members and member functions of class Binary are given below:

|                   |   |  |
|-------------------|---|--|
| Class name        | : | Binary   |
| Data members      |   |  |
| A[]               | : | integer array of 100 elements  |
| n                 | : | size of array  |
| l                 | : | location of the lower bound  |
| u                 | : | location of the upper bound  |
| Member functions: |   |  |
| Binary(int n)     | : | constructor to initialize the size n to nn and the other instance variables. |
| void readdata()   | : | to fill the elements of the array in ascending order.                        |

intbinary\_search(int v) : returns the location of the value(v) to be searched in the list by binary search method using the recursive technique. The function returns -1 if the number is not present in the given list.

- a) Specify the class Binary giving details of the constructor, void readdata() and intbinary\_search(int). you need not write the main function. [ 8 ]
- b) State the base case in the recursive technique binary\_search(). [ 1 ]
- c) What are the drawbacks of using the recursive technique. [ 1 ]

**Question 14.**

A class SortWord has been defined with the following details:

|                  |   |  |
|------------------|---|--|
| Class name       | : | SortWord   |
| Data members     |   |  |
| txt              | : | stores the word.   |
| len              | : | stores the length of the word.   |
| Member functions |   |  |
| SortWord()       | : | default constructor  |
| voidreadTxt()    | : | to accept the word in lower case.  |
| voidsortTxt()    | : | to sort the word in alphabetical order of characters using bubble sort technique and display it. |
| voidchangeTxt()  | : | to change the case of vowels in the word to upper case. For example :- school becomes school.    |
| voiddisp()       | : | to display the changed string.   |

Specify the class SortWord giving the details of the functions constructor, void readTxt(), void sortTxt(), void changeTxt() and void disp(). You need not write the main function.

[ 10 ]