

**Computer Science
Paper 1
Theory
Year 2016**

**Part I
Answer all questions**

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

Question 1.

- a) State Involution law and prove it with a truth table. [1]
b) Show that $X \vee \sim(Y \wedge X)$ is a tautology. [1]
c) Find the dual of :
 $Y.X + X'+1 = 1$ [1]
d) Write the maxterm and minterm, when the inputs are A=0, B=1, C=1 and D=0. [1]
e) Draw the logic circuit of a NAND gate using NOR gates only. [1]

Question 2.

- a) Define the term fall through condition with reference to switch () case. [2]
b) Convert the following infix expression to postfix form:
 $A + B / C * (D / E * F)$ [2]
c) A matrix A[m][n] is stored with each element requiring 4 bytes of storage. If the base address at A[1][1] is 1500 and the address at A[4][5] is 1608, determine the number of rows of the matrix if it is stored in Column Major Wise. [2]
d) From the class declaration given below, state the nature of the identifiers A, B, C and D :
class A extends B implements C, D [2]
e) State one advantage and one disadvantage of using recursion over iteration. [2]

Question 3.

The following function Check() is a part of some class. What will the function Check() return when the values of both m and n are equal to 5? Show the dry run/ working.

```
int Check(int m, int n)
{
    if(n==1)
        return -- m - -;
    else
        return ++m + Check(m, -- n);
}
```

[5]

Part II (50 Marks)

Answer 6 questions in this part , choosing two from Section A, two from Section B and two from Section C.

Section A

Answer any 2 questions

Question 4.

a) Given the Boolean function $F(A,B,C,D)= \Sigma(1,3,5,7,8,9,10,11,14,15)$.

i) Reduce the above expression by using 4- variable Karnaugh map, showing the various groups (i.e.octals, 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 :

$F(A,B,C,D)= \Pi(4,6,7,10,11,12,14,15)$

i) Reduce the above expression by using 4- variable Karnaugh map, showing the various groups (i.e.octals, 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) What is a decoder? [3]

b) How is a half adder different from a full adder? Draw the truth table and derive the sum and carry expression for a full adder. Also draw the logic diagram for a full adder. [4]

c) State whether the following expression is a Tautology, Contradiction or a Contingency, with the help of a truth table:

$(X \rightarrow Z) \vee \sim[(X \rightarrow Y) \wedge (Y \rightarrow Z)]$ [3]

Question 6.

a) A passenger is allotted a window seat in an aircraft, if he/she satisfies the criteria given below:

- The passenger is below 15 years and is accompanied by an adult.
OR
- The passenger is a lady and is not accompanied by an adult.
OR
- The passenger is not below 15 years, but is travelling for the first time.

The inputs are:-

INPUTS	
A	The passenger is below 15 years of age
C	The passenger is accompanied by an adult
L	The passenger is a lady
F	The passenger is travelling for the first time

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

Output: W- Denotes the passenger is allotted a window seat(1 indicates yes and 0 indicates no).

Draw the truth table for the inputs and outputs given above and write the SOP expression for $W(A,C,L,F)$. [5]

b) State the complement properties. Find the complement of the following Boolean expression using De Morgan's law:

$AB'+A'+BC$ [3]

c) Differentiate between canonical form and cardinal form of expression. [2]

Section B

Answer any 2 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 disarium number is a prime number in which the sum of digits to the power of their respective position is equal to the number itself. Example :- $135 = 1^1 + 3^2 + 5^3$

Hence 135 is a disarium number.

Design a class Disarium to check if a given number is a disarium number or not. Some of the members of the class are given below:

Class name : Disarium

Data Members :

int num : stores the number

int size : stores the size of the number

Member methods

Disarium(int nn) : parameterized constructor to initialize the data members n=nn and size =0

void countDigit() : counts the total number of digits and assigns it to size

int sumofDigits(int n, int p): returns the sum of the digits of the number (n) to the power of their respective positions (p) using recursive technique.

void check() : checks whether the number is a disarium number and displays the result with an appropriate message.

Specify the class Disarium giving the details of the constructor(), void countDigit(), int sumofDigits(int, int) and void check(). Define the main function to create an object and call the functions accordingly to enable the task. [10]

Question 8.

A class Shift contains a two dimensional array of order (m x n) where the maximum values of both m and n is 5. Design the class Shift to shuffle the matrix (i.e. the first row becomes the last, the second row becomes the first and so on). The details of the members of the class are given below:

Class Name : Shift

Data members

mat [][] : stores the array element

m : integer to store the number of rows

n : integer to store the number of columns

Member functions

Shift(int mm, int nn) : parameterized constructor to initialize the data members m=mm and n=nn

void input() : enters the elements of the array

void cyclic(Shift P) : enables the matrix of the object P to shift each row upwards in a cyclic manner and store the resultant matrix in the current object.

void display() : displays the matrix elements

Specify the class Shift giving details of the constructor(), void input(), void cyclic(Shift). Define the main function to create an object and call the methods accordingly to enable the task of shifting the array elements. [10]

Question 9.

A class consChange has been defined with the following details:

Class name : ConsChange

Data Members

word : stores the word
len : stores the length of the word

Member functions

ConsChange() : default constructor
void readword() : stores the length of the word
void shiftcons() : shifts all the consonants of the word at the beginning followed by the vowels (eg. Spoon becomes spnoo)
void changeword() : changes the case of all occurring consonants of the shifted word to uppercase, for eg. Spnoo becomes SPNoo).
void show() : displays the original word, shifted word and the changed word.

Specify class ConsChange giving the details of the constructor(), void readword(),void shiftcons(), void changeword() and void show(). Define the main function to create an object and call the functions accordingly to enable the task. [10]

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 psuedocodes 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 Bank has been defined to store the details of the customer. Define a subclass Account that enables transactions for the customer with the bank. The details of both the classes are given below:

class Name : Bank

Data Members

name : stores the name of the customer
accno : stores the account number
p : stores the principal amount in decimals

Member functions

Bank(...): parameterized constructor to assign values to the instance variables.
void display() : displays the details of the customer

Class name	:	Account
Data members		
amt	:	stores the transaction amount in decimals
Member Functions		
Account(...)	:	parameterized constructor to assign values to the instance variables of both classes.
void deposit()	:	accepts the amount and updates the principal as $p = p + \text{amt}$
void withdraw()	:	accepts the amount and updates the principal as $p = p - \text{amt}$ If the withdrawal amount is more than the principal amount , then display the message “Insufficient balance “. If the principal amount after withdrawal is less than 500, then a penalty is imposed by using the formula $p = p - (500 - p) / 10$.
void display()	:	displays the details of the customer.

Assume that the super class Bank has been defined . Using the concept of inheritance, specify the class Account giving details of the constructor(...), void deposit(), void withdraw() and void display().
The super class and main function need not be written. [5]

Question 11.

A bookshelf is designed to store the books in a stack with LIFO (Last In First Out) operation. Define a class Book with the following specifications:

class name	:	Book
Data members		
name[]	:	stores the names of the books
point	:	stores the index of the topmost book
max	:	stores the maximum capacity of the bookshelf
Member Functions		
Book(int cap)	:	constructor to initialize the data members $\text{max} = \text{cap}$ and $\text{point} = -1$
void tell()	:	displays the name of the book which was last entered in the shelf. If there is no book left in the shelf, displays the message “Shelf Empty”.
void add(String v)	:	adds the name of the book to the shelf if possible, otherwise displays the message “Shelf full”.
void display()	:	displays all the names of the books available in the shelf.

Specify the class Book giving details of ONLY the functions void tell() and void add(String). Assume that the other functions have been defined. The main function need not be written. [5]

Question 12.

a) A linked list is formed from the objects of the class Node. The class structure of the Node is given below:

```
class Node
{
    String name;
    Node next;
}
```

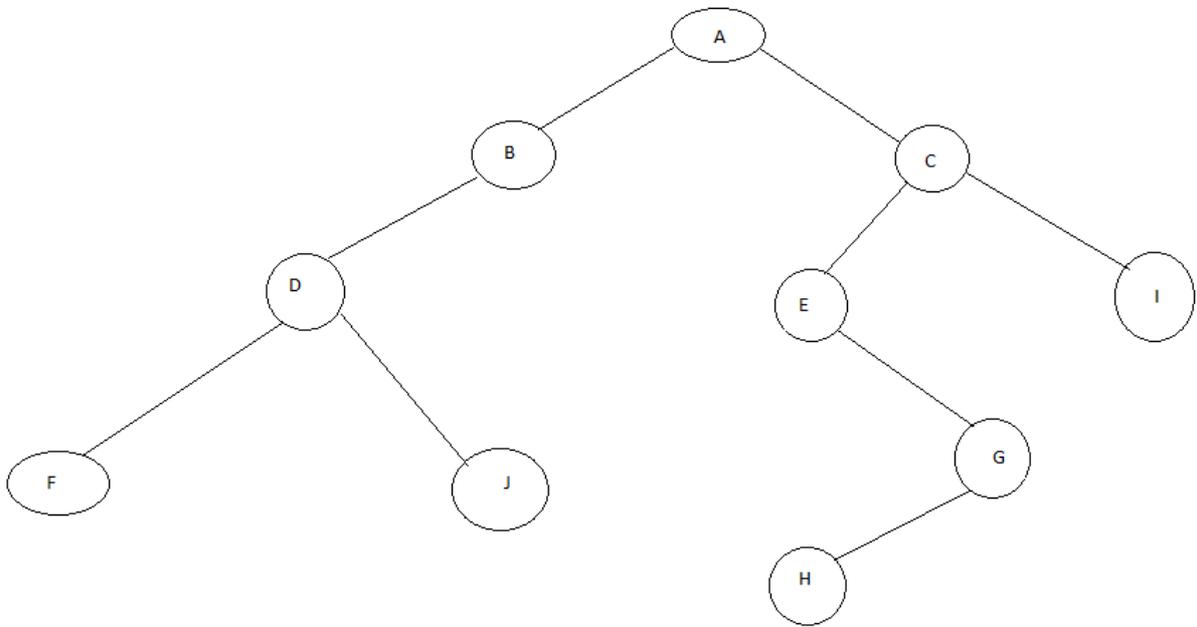
Write an algorithm or a method to search for a given name in the Linked list. The method

declaration is given below:

boolean searchName(Node start, String v)

[2]

b) Answer the following questions from the diagram of the binary tree given below:



i) Write the inorder traversal of the above tree structure.

[1]

ii) Name the parents of the node B and G.

[1]

iii) Name the leaves of the right subtree.

[1]