

Computer Science
Paper 1 (Theory)
Part I

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

Question 1.

- a) Using truth table, verify the following expression:
$$X + (Y + Z) = (X + Y) + Z$$

Also state the law.
- b) Given, $F(X, Y, Z) = (X' + Y') \cdot (Y + Z')$
write the function in canonical product of sum form.
- c) Draw the truth table and logic circuit for a 2 – input XNOR gate.
- d) Find the complement of the following expression:
$$X' + XY'$$
- e) If $(X \rightarrow Y)$ then write its:
 - i) Converse
 - ii) Contra positive

[2 x 5 = 10]

Question 2.

- a) Differentiate between the keyword extends and implements.
- b) State how a binary tree is a recursive data structure.
- c) A matrix $B[10][7]$ is stored in the memory with each element requiring 2 bytes of storage. If the Base address at $B[x][1]$ is 1012 and the address $B[7][3]$ is 1060, determine the value x where the matrix is stored in column major wise.
- d) Convert the following infix notation into its postfix form:
$$A + ((B + C) + (D + E) * F) / G$$
- e) What is a constructor? State one difference between a constructor and any other member function of a class.

[2 x 5 = 10]

Question 3.

- a) The following function is a part of some class which computes and sorts an array `arr[]` in ascending order using the bubble sort technique. There are some places in the code marked by ?1?, ?2?, ?3?, ?4?, ?5? which must be replaced by a statement/ expression so that the function works properly:

```

class Trial
{
void bubblesort(intarr[])
{
inti,j,k,tmp;
for(i=0;?1?;i++)
{
for(j=0;?2?;j++)
{
if(arr[j]>?3?)
{
tmp=arr[j];
?4?=arr[j+1];
arr[j+1]=?5?;
}
}
}
}
}

```

- i) What is the expression or statement at ?1?
- ii) What is the expression or statement at ?2?
- iii) What is the expression or statement at ?3?
- iv) What is the expression or statement at ?4?
- v) What is the expression or statement at ?5?

[1 x 5 = 5]

- b) The following function witty() is a part of some class. What will be the output of the function witty() when the value of n is "SCIENCE" and the value of p is 5. Show the dry run/ working:

```

class Trial1
{
public void witty(String n, int p)
{
if(p<0)
System.out.println("");
else
{
System.out.println(n.charAt(p)+".");
witty(n,p-1);
System.out.print(n.charAt(p));
}
}
}

```

[5]

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 $F(A,B,C,D) = \sum(4,6,7,10,11,12,14,15)$
- Reduce the above expression by using 4 variable K- map, showing the various groups (i.e. octals, quads and pairs).
 - Draw the logic gate diagram of the reduced expression. Assume that the variables and their complements are available as inputs.

[4 + 1 = 5]

- b) Given the Boolean function $F(P,Q,R,S) = \pi(0,5,7,8,10,12,13,14,15)$
- Reduce the above expression by using 4 variable K- map, showing the various groups (i.e. octals, quads and pairs).
 - Draw the logic gate diagram of the reduced expression. Assume that the variables and their complements are available as inputs.

[4 + 1 = 5]

Question 5.

The principal of a school intends to select students for admission to Class XI on the following criteria:

- Student is of the same school and has passed the Class X Board Examination with more than 60% marks.
OR
- Student is of the same school, has passed the Class X Board Examination with less than 60% marks but has taken active part in co-curricular activities.
OR
- Student is not from the same school but has either passed the Class X board Examination with more than 60% marks or has participated in Sports at the national level.

The inputs are :

INPUTS

S	Student is of the same school
P	Has passed the Class X Board Examination with more than 60% marks.
C	Has taken active part in co-curricular activities.
T	Has participated in sports at the National Level.

Output :-

X – Denotes admission status [1 indicates granted and 0 indicates refused in all the cases.]

- Draw the truth table for the inputs and outputs given above and write the SOP expression.
- Reduce $X(S,P,C,T)$ using Karnaugh's map.
Draw the logic gate diagram for the reduced SOP expression for $X(S,P,C,T)$ using AND and OR gate. You may use gates with two or more inputs. Assume that the variable and their complements are available as inputs.

[5 x 2 = 10]

Question 6.

- a) Verify algebraically if,

$$X'Y'Z' + X'Y'Z + X'YZ + X'YZ' + XY'Z' + XY'Z = X' + Y'$$

[2]

- b) Represent the Boolean expression
- $X + YZ'$
- with the help of NOR gates only.

[2]

- c) Define the terms contingency, contradiction and tautology.

[3]

- d) Consider the following truth table where A and B are two inputs and X is the output:

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

- i) Name and draw the logic gate for the given truth table.

[2]

- ii) Write the POS of
- $X(A,B)$

[1]**Question 7.**

- a) Define multiplexer and state one of its uses. Draw the logic gate diagram for 4:1 Multiplexer.

[4]

- b) State how a half adder is different from a full adder. Also give their respective uses.

[3]

- c) Minimize the following expression using Boolean laws:

$$Q(Q' + P).R.(Q + R)$$

[3]

Also draw the logic gate for the reduced Boolean expression.

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.

Question 8.

A class Combine contains an array of integers which combines two arrays into a single array including the duplicate elements, if any, and sorts the combined array. Some of the members of the class are given below:

Class Name	:	Combine
Data members		
com[]	:	integer array
size	:	size of the array
Member functions/methods		
Combine(intnn)	:	parameterized constructor to assign size = nn
void inputarray()	:	to accept the array elements
void sort()	:	sorts the elements of combined array in ascending order using the selection sort technique.
void mix(Combine A, Combine B)	:	combines the parameterized object arrays and stores the result in the current object array along with the duplicate elements , if any.
void display()	:	displays the array elements.

Specify the class Combine giving details of the constructor(int), void inputarray(), void sort(), void mix(Combine, Combine) and void display(). Also define the main function to create an object and call the methods accordingly to enable the task.

[10]

Question 9.

Design a class VowelWord to accept a sentence and calculate the frequency of words that begin with a vowel. The words in the input string are separated by a single blank space and terminated by a full stop. The description of the class is given below:

Class Name	:	VowelWord
Data members		
str	:	to store a sentence
freq	:	to store the frequency of words beginning with a vowel.
Member functions		
VowelWord()	:	constructor to initialize data members to legal initial values.
void readstr()	:	to accept a sentence.
void freq_vowel()	:	counts the frequency of the words beginning with a vowel.
void display()	:	to display the original string and the frequency of the

words that begin with a vowel.

Specify the class VowelWord giving details of the constructor(), void readstr(), void freq_vowel() and void display(). Also defining the main function to create an object and call the methods accordingly to enable the task.

[10]

Question 10.

A happy number is a number in which the eventual sum of the square of the digits of the number is equal to 1.

Example :

$$\begin{aligned} 28 &= (2)^2 + (8)^2 = 4 + 64 = 68 \\ 68 &= (6)^2 + (8)^2 = 36 + 64 = 100 \\ 100 &= (1)^2 + (0)^2 + (0)^2 = 1 + 0 + 0 = 1 \end{aligned}$$

Hence 28 is a happy number.

Example :

$$12 = (1)^2 + (2)^2 = 1 + 4 = 5$$

Hence 12 is not a happy number.

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

Class Name	:	Happy
Data Members		
n	:	stores the number
Member functions:		
Happy()	:	constructor to assign 0 to n
voidgetnum(intnn)	:	to assign the parameter value to the number n = nn
intsum_sq_digits(int x)	:	returns the sum of the square of the digits of the number x, using the recursive technique.
voidishappy()	:	checks if the given number is a happy by calling the functionsum_sq_digits(int) and displays an appropriate message.

Specify the class Happy giving details of the constructor(), void getnum(int), intsum_sq_digits(int) and void ishapp(). Also define a main function to create an object and call the methods to check for a happy number.

Section C

Answer any 2 questions.

Each program/algorithm should be written in such a way that it clearly depicts the logic of the problem step wise. This can also be achieved by using pseudo codes.

(Flowcharts are not required)

The programs must be written in Java.

The algorithm must be written in general standard form wherever required.

Question 11.

Link is an entity which can hold a maximum of 100 integers. Link enables the user to add elements from the rear end and remove integers from the front end of the entity. Define a class Link with the following details:

Class Name	:	Link
Data members		
Ink[]	:	entity to hold the integer elements.
max	:	stores the maximum capacity of the entity.
begin	:	to point to the index of the front end.
end	:	to point to the index of the rear end.
Member functions		
Link(int mm)	:	constructor to initialize max=mm, begin=0, end=0.
void addlink(int v)	:	to add an element from the rear index if possible otherwise display the message " OUT OF SIZE ".
int dellink()	:	to remove and return an element from the front index, if possible otherwise display the message " EMPTY... " and return -99.
void display()	:	displays the elements of the entity.

- a) Specify the class Link giving details of the constructor(int), void addlink(int), int dellink() and void display().

THE MAIN FUNCTION AND ALGORITHM NEED NOT BE WRITTEN.

[9]

- b) What type of data structure is the above entity?

[1]

Question 12.

A super class Detail has been defined to store the details of a customer. Define a sub class Bill to compute the monthly telephone charge of the customer as per the chart given below:

NUMBER OF CALLS	RATE
1- 100	Only rental charge
101-200	60 paisa per call + rental charge
201-300	80 paisa per call + rental charge
Above 300	1 rupee per call + rental charge

The details of both the classes are given below:

Class Name : **Detail**

Data members

name : to store the name of the customer.
address : to store the address of the customer.
telno : to store the phone number of the customer.
rent : to store the monthly rental charge

Member functions:

Detail(..) : parameterized constructor to assign values to data members.
void show() : to display the detail of the customer.

Class Name : **Bill**

Data members

n : to store the number of calls.
amt : to store the amount to be paid by the customer.

Member functions:

Bill(..) : parameterized constructor to assign values to data Members of both classes and to initialize amt = 0.0.
void cal() : calculates the monthly telephone charge as per the charge given above.
void show() : to display the detail of the customer and amount to be paid.

Specify the class Detail giving details of the constructor() and void show(). Using the concept of inheritance, specify the class Bill giving details of the constructor(), void cal() and void show().

THE MAIN FUNCTION AND ALGORITHM NEED NOT BE WRITTEN.

[10]

Question 13.

- a) A linked list is formed from the objects of the class,

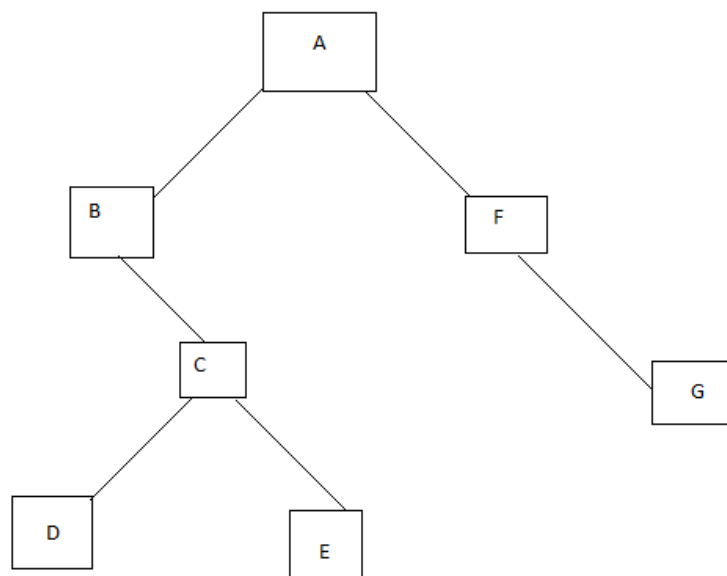
```
class node
{
    int p;
    String n;
    node next;
}
```

Write an algorithm or a method to search for a name and display the contents of the node. The method declaration is given below:

void search(node start, String b)

[4]

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



- | | | |
|------|--------------------------------|--------------|
| i) | External nodes of the tree. | [1] |
| ii) | Parent node of D. | [1] |
| iii) | Inorder traversal of the tree. | [1] |
| iv) | Right subtree of node B. | [1] |