

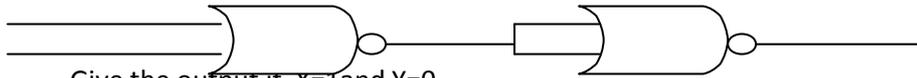
**Computer Science
Paper 1
Theory
Year 2015
Part I**

Answer all questions.

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

Question 1.

- a) Simplify:
 $(A+C).(A+AD)+AC+C$
- b) Draw a logic circuit for $(A+B).(C+D).C$
- c) Verify the following proposition with the help of a truth table:
 $P \vee (\sim P \wedge Q) = P \vee Q$
- d) State De Morgan's law and verify it, using a truth table.
- e) Answer the questions related to the circuit given below:-



- i) Give the output if, $X=1$ and $Y=0$
- ii) Name the basic gate represented by the above diagram.

[2 X 5 = 10]

Question 2.

- a) Define computational complexity. Calculate the complexity using Big 'O' notation for the following code segment:-

```
for(int k=0;k<n;k++)
    s+=k;
```

- b) Convert the following infix notation into postfix form:

$X+Y(Y-Z) + ((W+E) * F) / J$

- c) Differentiate between this keyword and super keyword.
- d) The array $D[-2...10][3...8]$ contains double type elements. If the base address is 4110, find the address of $D[4][5]$, when the array is stored in Column Majorwise.
- e) State any two characteristics of a Binary Tree.

[2 x 5 = 10]

Question 3.

- a) The following function is a part of some class. Assume 'x' and 'y' are positive integers, greater than 0. Answer the given questions along with dry run / working.

```
void someFun(int x, int y)
{
    if(x>1 )
    {
        i(x%y==0)
        {
            System.out.print(y+ " ");
        }
    }
}
```

```

        someFun(x/y, y);
    }
    else
        someFun(x, y+1);
}
}

```

- i) What will be returned by someFun(24,2)?
- ii) What will be returned by someFun(84,2)?
- iii) State in one line what does the function someFun() do apart from recursion?
[2 + 2 + 1= 5]

- b) The following is a function of some class which checks if a positive integer is an Armstrong number by returning true or false. (A number is said to be Armstrong if the sum of the cubes of all its digits 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 Armstrong(int N)
{
int sum =?1?;
int num=N;
while(num>0)
{
int f= num/10;
int s= ?2?;
int digit = sum - s;
sum+=?3?;
num= ?4?;
}
if(?5?)
return true;
else
return false;
}

```

Question 4.

- a) Given the Boolean function $F(A, B, C, D) = \pi(0, 1, 2, 3, 5, 7, 8, 9, 10, 11)$
 - 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 :-
 $P(A, B, C, D) = ABC'D' + A'BC'D' + A'BC'D + ABC'D + ABC'D + A'BCD + ABCD$
 - 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 person is allowed to travel in a reserved coach of the train, if he / she satisfies the criteria given below:-

- The person has a valid reservation ticket and a valid ID proof.
OR
- The person does not have a valid reservation ticket, but holds a valid pass issued by the Railway department with a valid ID proof.
OR
- The person is a disabled person and holds a valid pass issued by the Railway department along with a valid ID proof.

The inputs are:

INPUTS	
R	The person has a valid reservation ticket
P	The person holds a valid pass issued by the Railway department
D	The person has a valid ID proof
H	The person is a disabled person

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

Output :- T - Denotes allowed to travel (1 indicates yes and 0 indicates no in all the cases)

- a) Draw the truth table for the inputs and outputs given above and write the POS expression for T(R,P,D,H).
- b) Reduce T(R,P,D,H) using Karnaugh map.

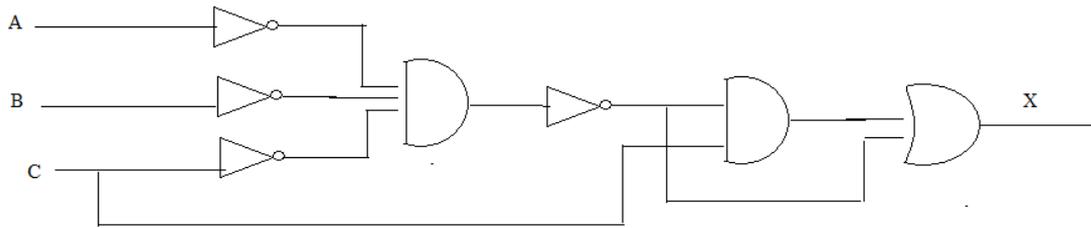
Draw the logic gate diagram for the reduced POS expression for T(R,P,D,H) using NOR gates. You may use gates with more than 2 inputs. Assume that the variables and their complements are available as inputs.

Question 6.

- a) Draw the truth table and logic gate diagram for an Octal to Binary encoder. [4]
- b) What is a multiplexer? State an application of a Multiplexer. Also, draw the logic diagram of a 4:1 multiplexer. [4]
- c) Verify the following expression using Boolean laws. Also mention the law used at each step of simplification.
 $XYZ + XY'Z + XYZ' = X \cdot (Y+Z)$ [2]

Question 7.

- a) Derive a Boolean expression for the logic circuit given below and reduce the derived expression, using Boolean laws: [3]



- b) What are universal gates? Construct a logic circuit using NAND gates only for the expression: $A.(B+C)$. [3]
- c) Define Half Adders. Draw the circuit diagram and truth table for a Half Adder. [4]

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 Admission contains the admission numbers of 100 students. Some of the data members/ member functions are given below:

Class name	:	Admission
Data members		
Adno[]	:	integer array to store admission numbers
Member functions		
Admission()	:	constructor to initialize the array elements.
voidfillArray()	:	to accept the elements of array in ascending order.
IntbinSearch(intl,int u, int v)	:	to search for a particular admission number(v) using binary search and recursive technique and returns 1 if found otherwise returns -1.

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

Question 9.

A class Merger concatenates two positive integers that are greater than 0 and produces a new merged integer. Example :- If the first number is 23 and the second is 764, then the concatenated number will be 23764. Some of the members of the class are given below:

Class name	:	Merger
Data members		
n1	:	long integer to store first number.
n2	:	long integer to store second number.
mergNum	:	long integer to store the merged number.
Member functions		

Merger()	:	constructor to initialize data members.
void readNum()	:	to accept the values of the data members n1 and n2.
Void JoinNum()	:	to concatenate the numbers n1 and n2 and store it in mergNum.
void show()	:	to display the original numbers and the merged numbers with appropriate messages.

Specify the class Merger, giving details of the constructor, void readNum(), void JoinNum() and void show(). Define the main function to create an object and call the functions accordingly to enable the task.

[10]

Question 10.

A class TheString accepts a string of a maximum of 100 characters with only one blank space between the words. Some of the members of the class are as follows:-

Class name	:	TheString
Data members		
str	:	to store a string
len	:	integer to store the length of a string
wordcount	:	integer to store the number of words
cons	:	integer to store the number of consonants
Member functions		
TheString()	:	default constructor to initialize the data members
TheString(String ds)	:	parameterized constructor to assign str=ds
voidcountFreq()	:	to count the number of words and number of consonants and store them in wordcount and cons respectively.
void Display()	:	to display the original string, along with the number of words and the number of consonants.

Specify class TheString giving details of the constructors, void countFreq() and void Dsisplay(). Define the main() function to create an object and call the functions accordingly to enable the task.

[10]

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 comment in the program and mnemonic names or pseudo codes for algorithms.

(Flowcharts are not required)

The programs must be written in Java.

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

Question 11.

WordPile is an entity which can hold maximum of 20 characters. The restriction is that a character can be added or removed from one end only. Some of the members of classes are given below:-

Class name	:	WordPile
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Data Members	
ch[]	: character array to hold the character elements
capacity	: integer variable to store the maximum capacity
top	: to point to the index of the topmost element
Member functions	
WordPile(int cap)	: constructor to initialize the data member capacity=cap, top=-1 and create the WordPile
void pushChar(char v)	: adds the character to the top of WordPile if possible, otherwise outputs a message "WordPile is full"
char popChar()	: returns the deleted character from the top of the WordPile if possible, otherwise returns '\\'

- Specify the class WordPile giving the details of the constructor, void pushChar(char) and char popChar(). The main function and algorithm need not be written. [8]
- What is the name of the entity describe above and state one of its applications. [2]

Question 12.

A line on a plane can be represented by coordinates of two end-points p1 and p2 as pi(x1,y1) and p2(x2,y2).

A super class Place is defined to represent a line and a sub class Circle to find the length of the radius and the area of a circle by using the required data members of super class. Some of the members of both the classes are given below:

Class name	:	Plane
Data members		
x1	:	to store the x coordinates of the first end point
y1	:	to store the y coordinates of the first end point

Member Functions

Plane (intnx, intny)	:	Parameterized constructor to assign the data members x1=nx and y1=ny
void Show()	:	to display coordinates

Class name	:	Circle
-------------------	---	--------

Data members		
X2	:	to store the x coordinates of the second end point
Y2	:	to store the y coordinates of the second end point
radius	:	double variable to store the radius of a circle
area	:	double variable to store the area of a circle

Member functions

Circle(...)	:	Parameterized constructor to assign values to the data members of both the classes.
-------------	---	---

void findRadius()	:	to calculate the length of radius using the formula: $\frac{\sqrt{(x2-x1)^2+(y2-y1)^2}}{2}$ Assuming that x1,x2,y1,y2 are the coordinates of the two ends of the diameter of a circle.
--------------------	---	---

void findArea() : to find the area of a circle using formula πr^2 . The value of pie (π) is 22/7 or 3.14.

void Show() : to display both the co ordinates along with the length of the radius and area of the circle.

Specify the class Plane giving details of the constructor and void Show(). Using the concept of inheritance, specify the class Circle giving details of the constructor, void findRadius(), void findArea() and void Show(). The main function need not be written.

[10]

Question 13.

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

```
class Nodes
{
    int num;
    Nodes next;
}
```

Write an algorithm or a method to print the sum of nodes that contains only odd integers of an existing linked list.

The method declaration is as follows:-

```
void NodesCount(Nodes starPtr)
```

[4]

b) i) Give the meaning of the following common expression in Big O notation:

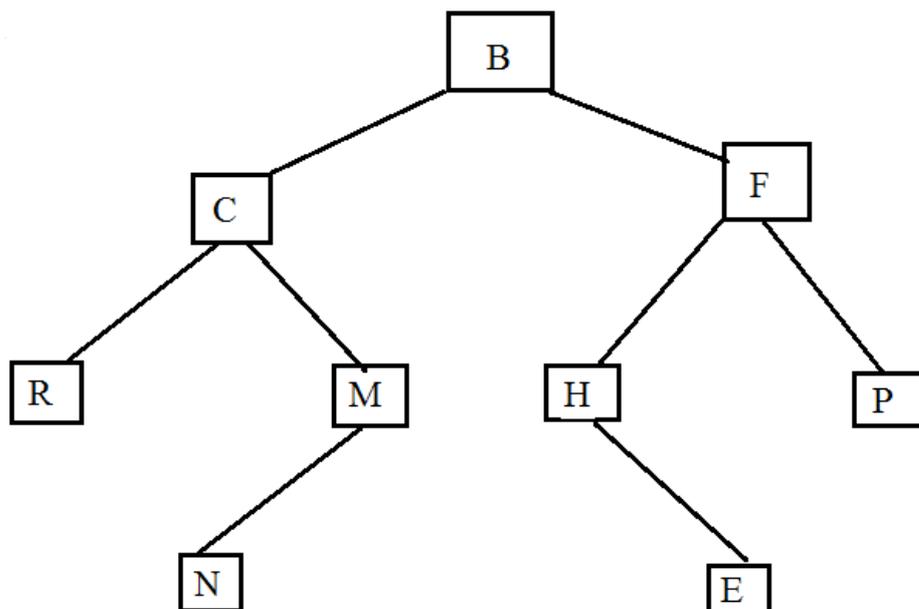
$O(N)$

$O(N^2)$

ii) List any 2 cases to analyse algorithm complexities.

[1]

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



- i) Name the leaf nodes of the right sub tree. [1]
- ii) Write postorder traversal of the left sub tree of node B including itself. [1]
- iii) State the level number of nodes R and M when the root is at level 0. [1]
- iv) Name the internals of the tree. [1]