This question paper contains **16** printed pages]

CODE : FRO-2017

COMPUTER ENGINEERING

Roll No. .....

Time : 3 Hours *Maximum Marks :* 200

Note :— (*i*) Question paper consists of two parts viz. Part I and Part II. Each part contains four questions. The paper as a whole carries eight questions. Question Nos. **1** and **5** are compulsory. The candidates are required to attempt *three* more questions out of the remaining six questions taking at least *one* question from each part i.e. this is in addition to the compulsory question of each part. Attempt *five* questions in all. All questions carry equal marks. The parts of a question are to be attempted at one place in continuation. Answers should be brief and to the points.

(*ii*) Parts of same question must be attempted together and not to be attempted in between the answers to other questions.

P.T.O.

Part–I

1. (*a*) A sequential circuit takes an input stream of 0's and 1's and produces an output stream of 0's and 1's. Initially it replicates the input on its output until two consecutive 0's are encountered on the input. From then onward, it produces an output stream which is the bit-wise complement of input stream until it encounters two consecutive 1's, whereupon the process repeats. An example of input and output stream is shown below :

The input stream:	1 0 1 1 0 0 0 1	0 0 1 0 1 1 0 1 1
The desired output:	1 0 1 1 0 0 1 0	1 1 0 1 0 0 0 1 1

J-K master-slave flip-fiops are to be used to design the circuit.

(*i*) Give the state transition diagram.

(*ii*) Give the minimized sum-of-product expressions for J and K inputs of one of its state flip flops.

(*b*) Consider a Linked List class :

(*i*) Write in Java a class List Element to represent the elements in a linked list.

(*ii*) Write a basic class LinkedList in Java using your element class fiom part (*a*). The class should have public methods to add an element to the front of a list, add an element to the end of the list, and to return an iterator. An iterator implementation should be provided as a nested class.

2. (*a*) (*i*) Minimise the following Boolean Function using Quine McCluskey tabulation method $F(W,X,Y,Z) = \Sigma m\ (0,3,5,6,7,10,12,13) + \Sigma d\ (2,9,15)$.

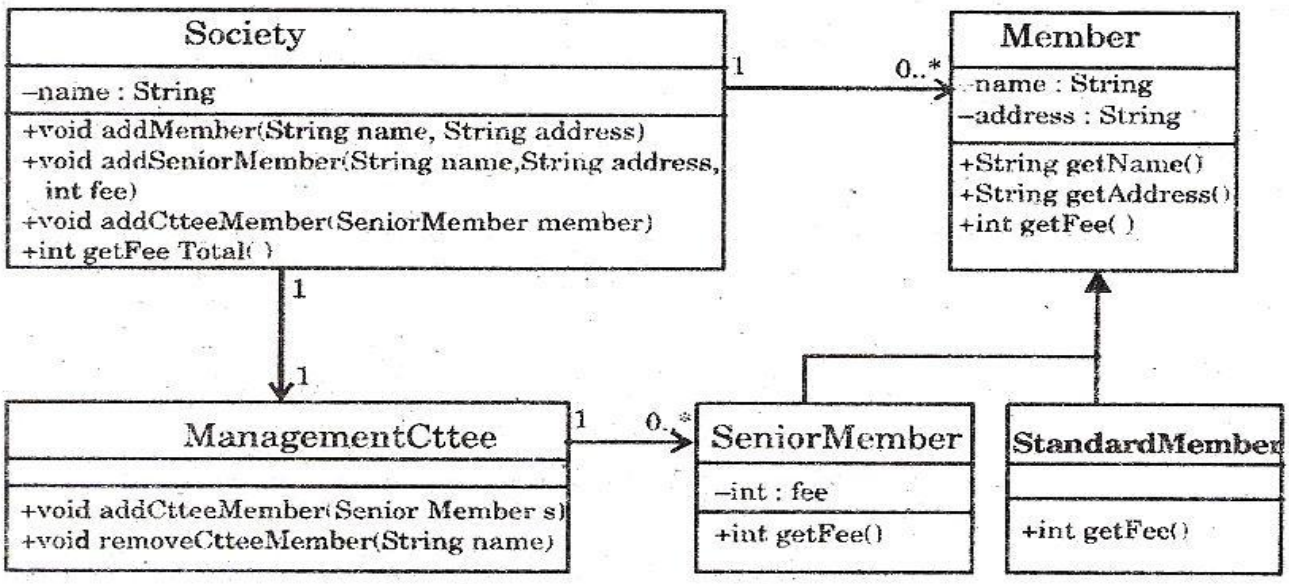
(*ii*) Using a decoder and external gates, design the combinational circuit defined by the following, three Boolean functions :

$F1 = (y' + x)z$

$F2 = y'z' + yz'$

$F3 = (x' + y)z$

(*b*) Consider this UML class diagram showing part of a program to manage the membership information for a professional society :



(*i*) Write a Java version of class ManagementCttee assuming it has this constructor :

public ManagementCttee( )

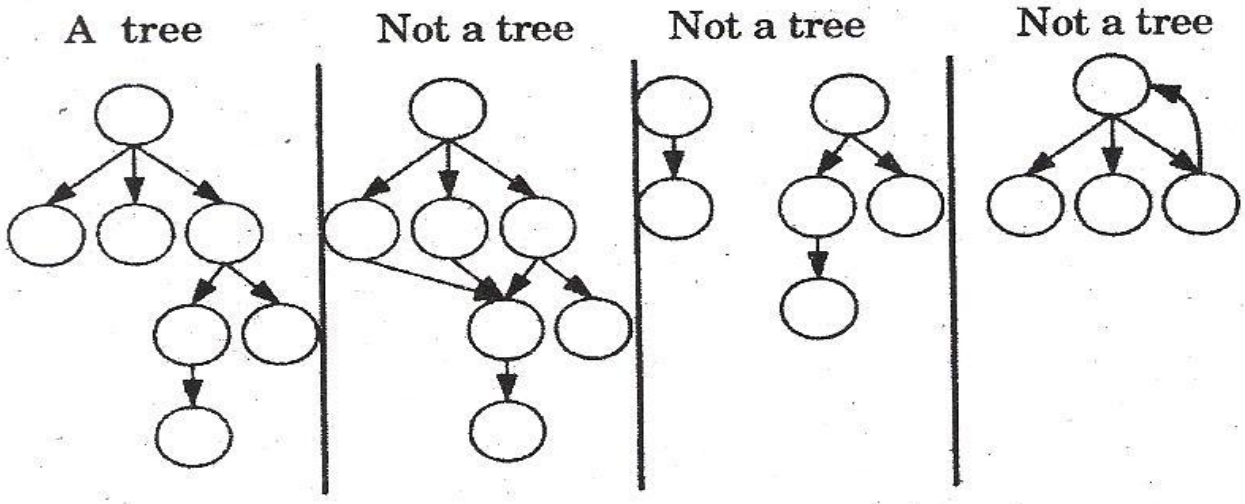
(*ii*) Class Member is an abstract class. Explain the role of an abstract class.

(*iii*) Write a Java version of class Member assuming it has this constructor: public Member (String name, String address) and that the method getFee( ) is abstract.

(*iv*) Write a Java version of class StandardMember assuming it has this constructor: public StandardMember (String name, String address) and the standard membership fee is fixed at Rs. 50.

3. (*a*) We can think of a tree as being a special kind of directed graph. To model a tree as a graph, we make the nodes of the tree become nodes in the graph, and draw an edge from a parent node to each of its children.

The drawing on the left shows a tree as a graph; the other three directed graphs do not correspond to a tree.



Suppose we want to check if a given directed graph corresponds to a tree. What properties should we

check that the graph has ? Write down a list of properties such that, if a directed graph has those properties, it must be a tree. You can refer to standard properties of graphs in your answer without explaining them.

(*b*) A university placement centre maintains a relational database of companies that interview students on campus and make job offers to those successful in the interview. The scheme of the database is given below :

COMPANY (cname, clocation)

STUDENT (srollno, sname, sdegree)

INTERVIEW (cname, srollno, idate)

OFFER (cname, srollno, osalary)

The COMPANY relation gives the name and location of the company. The STUDENT relation gives the student's roll number, name and the degree program for which the student is registered in the university. The INTERVIEW relation gives

the date on which a student is interviewed by a company. The OFFER relation gives the salary offered to a student who is successful in company's interview. The key for each relation is indicated by the underlined attributes.

(*i*) Write relational algebra expressions (using only the operators σ, π, $\cup$, $-$,) for the following queries :

(*a*) List the roll numbers and names of those students who attended at least one interview but did not receive any job offer.

(*b*) List the roll numbers and names of students who went for interview and received job offers from every company with which they interviewed.

(*ii*) Write an SOL query to list, for each degree program in which more than five students were offered jobs, the name of the degree and the average offered salary of students in this degree program.

4. (*a*) A computer uses 46-bit virtual address, 32-bit physical address, and a three-level paged page table organization. The page table base register stores the base address of the first-level table (T_1), which occupies exactly one page. Each entry of T_1 stores the base address of a page of the second-level table (T_2). Each entry of T_2 stores the base address of a page of the third-level table (T_3). Each entry of T_3 stores a page table entry (PTE). The PTE is 32 bits in size. The processor used in the computer has a 1 MB 16-way set associative virtually indexed physically tagged cache. The cache block size is 64 bytes. What is the minimum number of page colours needed to guarantee that no two synonyms map to different sets in the processor cache of this computer ?

(*b*) Show the result of the following sequence of operations in an array of size 10 below. The hash function is simply n mod 10. Perform this for :

(*i*) when linear probing is used to handle collisions and

(*ii*) when chaining is used.

Add 3 2 5 1 16 25

Remove 5

Add 10

Add 13

Remove 1

Remove 13

Part-II

5. (*a*) Consider two vectors A and B. The number of elements in each vector is N. The dot product of two vectors is defined as :

$$D = \sum_{i=0}^{N-1} A(i) \times B(i)$$

Where A(i) denotes the ith element of vector A, and B(i) denotes the ith element of vector B. Write an assembly language program to compute the dot product of two vectors A and B. The first element of vector A is stored at the memory location vector_A, the first element of vector B is stored

at the memory location vector_B, and the number of elements in each vector is stored at memory location N. Store the dot product in location DOTPROD. The word length of the processor is 4. The processor allows only two operand instructions, and in the two operand instructions only one of the operands may be in the memory. The other operand must be in a processor register.

(*b*) Let synthesized attribute val give the value of the binary number generated by S in the following grammar. For example, on input 101, 101, S.val = 5.625.

$S \rightarrow LL \mid L$

$L \rightarrow LB \mid B$

$B \rightarrow 0 \mid 1$

Write S-attributed values corresponding to each of the productions to find S.val.

6. (*a*) A company needs to develop a strategy for software product development for which it has a choice of two programming languages L_1 and L_2. The

number of lines of code (LOC) developed using L_2 is estimated to be twice the LOC developed with L_1. The product will have to be maintained for five years. Various parameters for the company are given in the table below :

Parameter	Language L_1	Language L_2
Man years needed for development	LOC/10000	LOC/10000
Development Cost per man year	Rs. 10,00,000	Rs. 7,50,000
Maintenance time	5 years	5 years
Cost of maintenance per year	Rs. 1,00,000	Rs. 50,000

Total cost of the project includes cost of development and maintenance. What is the LOC for L_1 for which the cost of the project using L_1 is equal to the cost of the project using L_2 ?

(*b*) Consider a disk with the following specifications : 20 surfaces, 1000 tracks/surface, 16 sectors/track, data density 1 KB/sector, rotation speed 3000 rpm. The operating system initiates the transfer between the disk and the memory sectorwise. Once the head has been placed on the right track, the disk reads a sector in a single scan. It reads bits from the sector while the head is passing over the sector. The read bits are formed into bytes in a serial-in-parallel-out buffer and each byte is then transferred to memory. The disk writing is exactly a complementary process.

For parts (*c*) and (*d*) below, assume memory read-write time = 0.1 micro-second/byte, interrupt driven transfer has an interrupt overhead = 0.4 micro-second, the DMA initialization and termination overhead is negligible compared to the total sector transfer time. DMA requests are always granted.

(*i*) What is the total capacity of the disk ?

(*ii*) What is the data transfer rate ?

(*iii*) What is the percentage of time the CPU is required for this disk *i/o* for bytewise interrupt driven transfer ?

(*iv*) What is the maximum percentage of time the CPU is held up for this disk *i/o* for cycle stealing DMA transfer ?

7. (*a*) Suppose that computer A is sending a file to computer B using a private Ethernet with no other computers using it. They are connected by 100 m of wire. Bits travel at the rate of 2×108 m/s in this wire. Suppose the Ethernet has a bandwidth of 109 bits per second ("gigabit Ethernet").

(*i*) Based on the provided information, what is the latency (i.e., propagation delay) of the connection ?

(*ii*) How long would it take for 106 bits to finish travelling from computer A to computer B ?

(*iii*) Suppose you measured the time it takes to transmit a 106 bit file from computer A to

computer B. To not include the time it takes for either computer to process the file, you start measuring from time the first bit of the file leaves computer A until last bit of the file reaches computer B. Furthermore, you make sure that the computers are fast enough that they do not limit the speed of transmission. Nevertheless, the time you measure is longer than time you calculated above. What factors could have resulted in this ?

(*b*) Briefly describe the Z-Buffer algorithm. Show its behaviour when applied to a frame buffer 4×4, black background and three rectangles, denoted by their vertices, the plane equation and colour :

R1 = ((1,1) (1,3) (2,3) (2,1)) Plane eq. $z = x + y + 4$ Color red

R2 = ((1,3) (1,4) (3,4) (3,3)) Plane eq. $z = 2x + 3y + 2$ Color green

R3 = ((2,3) (2,4) (4,4) (4,3)) Plane eq. $z = 3x + 2y$ Color blue

Assume that the maximum distance (z) is 64 and that the minimum one is 0.

8. (a) A rectangular clipping window is defined by the following window coordinates: (0, 0) for the left, bottom corner and (5, 4) for the right, top corner. We are also given two line segments: Line AB (from A(–1, –l) to B(6, 6)) and Line CD (from C(–1, l) to D(4, –3)) that we want to clip against the window using the Cohen-Sutherland Clipping algorithm. What is the sequence of bitcodes generated by the algorithm when it is run on the lines AB and CD. Also, mention what is the final result of the clipping.

The 4 bit bitcode PQRS are defined as per the following convention :

P is 1 if $x < 0$

Q is 1 if $x > 5$

R is 1 if $y < 0$

S is 1 if $y > 4$

(b) (*i*) Consider a DFA over $\Sigma = \{a, b\}$ accepting all strings which have number of a's divisible by 6 and number of b's divisible by 8. What is the minimum number of states that the DFA will have ?

(*ii*) Construct a regular expression corresponding to the automata given below :