

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY,
ALLAHABAD

C1

Date: 24/02/2023

Program Code & Semester : B.Tech.(IT) – 4th Semester

Paper Title: Database Management System

Note: All Questions are compulsory, make appropriate assumption and state them clearly whenever you think that it is desired in any Question.

1. Differentiate between following while giving appropriate example. (08X 02 = 08Marks)

1. Weak Entity &Strong Entity
2. Composite attribute and Derived attribute
3. Specialization and Generalization
4. Schema and Instance of a relation

2. branch(branch name, branch city, assets):

customer (customer name, customer street, customer city)

loan (loan number, branch name, amount) ✓

borrower (customer name, loan number):

account (account number, branch name, balance) ✓

depositor (customer name, account number)

Considering the bank database given above answer the following questions:

- a) What are the appropriate primary keys? (02 Marks)
- b) Given your choice of primary keys, identify appropriate foreign keys. (02 Marks)
- c) Draw a database schema diagram corresponding to the above set of relations. (02 Marks)
- d) Write a relational algebra expression for each of the following: (04X02=08 Marks)

1. Find the names of all customers who have a loan, an account, or both, from the bank and who live in city Brooklyn
2. Find the names of all customers who have a loan at the Perryridge branch of amount greater than \$2000.
3. Find the names of all customers who have an account at the Perryridge branch but do not have a loan at any branch of the bank.
4. Find the largest loan amount.

3. Write SQL query for each of the queries mentioned in question 2(d).

(02x4=08 Marks)

.....END.....

Indian Institute of Information Technology, Allahabad

Course: Computer Networks

Batch: B. Tech. (IT) - 4th semester (Section: B)

Enroll Nos. IT2021107 - IIT2021212

C1 Review Test

Instructor: Dr. Vijay K. Chaurasiya

MM: 60

Time: 2 Hrs

Note:

- Attempt All Questions.
- Write answer in brief. Unnecessary writing may result in negative marking.

1. Multiple Choice Questions. (More than one option may be right) (10 Marks)

i. The Signal to Noise ratio of an analog channel is 20 dB. Which of the following statements is/are correct?

- (a) $S/N = 10 \log_{10} 20$. (b) $S/N = 2 \log_2(1 + 20)$. (c) $S/N = 10^2$.
 (d) $S/N = 10^{(1020)}$. (e) $S/N = (1/10)^{220}$.

ii. The following bit strings show the transmitted and received bit patterns over a noisy serial data link.

Transmit: 01001011101000101101110011

Receive: 0101100110100110111110011

What is the length of the longest error burst?

- (a) 4 (b) 6 (c) 16 (d) 10 (e) 5

iii. Which is/are the correct statement(s) with respect to ISO/OSI and TCP/IP models?

- (a) OSI reference model implementation was made operational before TCP/IP.
 (b) Both have the same number of layers.
 (c) The network layer of the OSI model allows higher functionality than the IP layer of the TCP/IP model.
 (d) TCP/IP was developed with the aim of providing robust operations in the presence of failures, whereas, OSI developers have strictly focused on independence of the functions among the layers.
 (e) Popular network applications are mostly based on the OSI protocol model.

iv. Which of the following is/are NOT (a) layer(s) in TCP/IP protocol stack?

- (a) Application (b) Session (c) Transport (d) Internet (e) Host to Network

v. Which of the following cannot be used as a medium for 802.3 Ethernet?

- (a) A thick Coaxial cable (b) A thin Coaxial cable (c) A twisted pair cable
 (d) A microwave links (e) A fibre optics cable

vi. Which of the following modulation methods can have higher bit rates than the baud rate?

- (a) Frequency Modulation (b) Amplitude Modulation
 (c) Phase Modulation - 2 Phase method (d) Phase Modulation - 4 Phase method
 (e) MSK

vii. The check bits C₁, C₂ and C₃ of a Hamming code are correctly positioned in

- (a) D₁C₁C₂D₂D₃C₃. (b) C₁C₂D₁D₂D₃C₃.
 (d) C₁D₁C₂D₂C₃D₃. (e) C₁C₂D₁C₃D₂D₃. (c) C₃D₃C₂D₂C₁D₁.

viii. The IEEE equivalent for Token Ring Networks is

- (a) IEEE 802.4 (b) IEEE 802.12 (c) IEEE 802.3
 (d) IEEE 802.5 (e) IEEE 802.2

ix. Identify the unequal pair(s).

- (a) Physical Address - MAC Address (b) IP Address - Logical Address (c) Ethernet - IEEE 802.4
 (d) Token Bus - IEEE 802.5 (e) Serial port - COM1

- x. Which of the following indicates the increasing order of accuracy in error detection?
- CRC, Single Parity, Block Sum Check
 - Block Sum Check, CRC, Single Parity
 - Single Parity, CRC, Block Sum Check
 - Single Parity, Block Sum Check, CRC
 - CRC, Block Sum Check, Single Parity
2. Describe the responsibilities and protocols for each layer of OSI reference model. How OSI reference model is different from TCP/IP reference model? (10 Marks)
3. Explain the relationship between the socket system call and the bind system call a UNIX system? Describe their prototypes? What parameters will be passed for a STREAM Socket. (10 Marks)
4. Calculate the total time required to transfer a 1000-KB file in the following cases, assuming an RTT of 50 ms, a packet size of 1 KB data, and an initial $2 \times \text{RTT}$ of "handshaking" before data is sent: (10 Marks)
(a) The bandwidth is 1.5 Mbps, and data packets can be sent continuously.
(b) The bandwidth is 1.5 Mbps, but after we finish sending each data packet, we must wait one RTT before sending the next (stop and wait protocol),
(c) Suppose we have to use sliding window protocol for efficient bandwidth utilization then
i. What should be the size of sender's window?
ii. How many bits will be required for the sequence number for a flawless communication?
5. The ASCII (8 bit) code of the letter A is 65 in decimal notation. Draw the signal diagram (discrete time signal) of the transmission of the two letter message "HI". Assume that the voltage level at time $t = 0$ is high, draw the signal diagram to show Manchester encoding and Minimum Shift Keying (MSK) modulation for the bit stream so obtained. (10 Marks)
6. Suppose we want to transmit the message 1011 0010 0100 1011 and protect it from errors using the CRC8 polynomial $x^8 + x^2 + x^1 + 1$.
(a) Use polynomial long division to determine the message that should be transmitted.
(b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of the receiver's CRC calculation? How does the receiver know that an error has occurred? (10 Marks)

*****END OF PAPER*****



भारतीय सूचना प्रौद्योगिकी संस्थान इलाहाबाद
Indian Institute of Information Technology Allahabad
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 Deoghat Jhalwa, Allahabad-211015 (U.P.) INDIA

Department of Information Technology

Design and Analysis of Algorithms, C1 Review Test – 20th February 2023

B.Tech. IT & IB (IV semester)

Duration: 1 hr.

Maximum Marks: 30

Instructions:

1. All questions are compulsory. All the subparts of a question are to be attempted together.
2. Write pseudocode wherever required.

Q1. Solve the following recurrences only using Master's Theorem [6]

- a. $T(n) = 16T\left(\frac{n}{4}\right) + n^2$
- b. $T(n) = 3^n T\left(\frac{n}{3}\right) + n^n$
- c. $T(n) = T\left(\frac{n}{2}\right) + n(2 - \cos n)$

Q2. Solve the following recurrence relation without using Master's Theorem. [4]

$$T(n) = 49T\left(\frac{n}{25}\right) + (\sqrt{n})^3 \log_2 n$$

Q3. Answer the following.

- a. Suppose we have a $O(n)$ time algorithm that finds the median of an unsorted array. Now consider a QuickSort implementation where we first find the median using the above algorithm, then use the median as a pivot. What will be the worst-case time complexity of this modified QuickSort and why? State the recurrence relation for the same and then solve it without using Master's theorem. [5]

- b. There are n people born between the year 0 A.D. and the year 2023 A.D. Propose the most efficient algorithm to sort all of them by birthdate, in the format DDMMYYYY, and compute its complexity. Give proper justification. [5]

Q4. Assume a student is represented with two features height (h) and weight (w). Similarity between each pair of students needs to be measured. [10]

- a. Suppose there are n students in the class, then propose an efficient algorithm to find similarity between each pair of students. Compute the exact time and space complexity of the algorithm.
- b. Propose an efficient algorithm to find the k similar students from any given student. Comment on the time and space complexity.

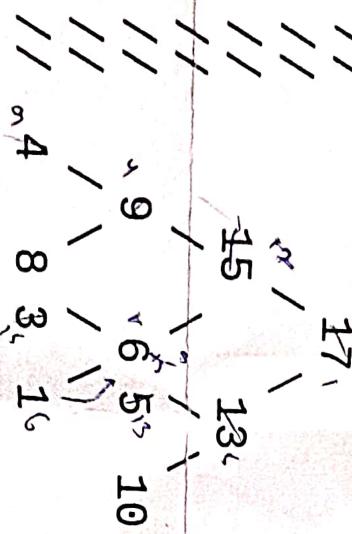
Q1. Write a C program uses a stack of size 100 characters to determine if an input string is a palindrome or not. A string is said to be a palindrome if it reads the same forward and backward. For example, abcba is a palindrome while abcbc is not. Assume that **push()** will never be called on a full stack and **pop()** will never be called on an empty stack. Use appropriate C string library function(s) if needed.

Q2. You are given a max-heap of 11 elements in the contiguous array representation.

Array representation of Heap is:

17 15 13 9 6 5 10 4 8 3 1

// The Heap:



Your task is to create a binary tree storing the same heap in the standard pointer-based representation.

Sample Output :

Array = {1, 3, 5, 4, 6, 13, 10, 9, 8, 15, 17}

Indian Institute of Information Technology Allahabad
 Software Engineering
 C2 Review Test (B.Tech. IV Semester)

Instructions: If required, make necessary assumptions and clearly mention them.

[90 Mins]

Q1: Consider yourself in the role of a software architect for an organization that is to develop a software solution for three problems described below.

- PlayTeams** A mobile/web application that facilitates users to create a fantasy team. These teams can be created 20 mins prior to start of a sports match in real world. Sports supported by the application are limited to Cricket, Badminton, and Football. Users will require to pay a small amount of participation fees and winner would be rewarded with monetary prize.
- TextNinja** Aim of this solution is to assist its users to analyze medium to large text files. Tasks include search and/or replace, frequency, sort, and plotting analysis data etc.
- OneStop** An e-commerce software solution that allows users to order various everyday life items and keeps itself updated with payment systems to serve customers well. Further, it has to aim for 99.5% availability round the clock.

Name two architectural styles (e.g. monolith or client-server) for each problem. Further, assign a priority to them and Justify your selection of architectures. **[2.5 + 2.5 + 2.5 Marks]**

Q2: Provide a pseudo code or algorithmic style description (assign a line number to each statement) of a program that violates the single responsibility principle. Further, provide the refactored program (mention line numbers rather than a complete statement). Note that the example must be different from the Fibonacci-Prime example discussed in class. **[2.5 Marks]**

Q3: Figures 1 and 2 show four faulty programs. Each includes a test case that results in failure. Answer the following questions about each program.

- Identify and fix the fault. **[2 Marks]**
- If possible, identify a test case that does not execute the fault. **[1 Marks]**
- If possible, identify a test case that executes the fault but does not result in an error state. **[1 Marks]**

```
public int findLast (int[] x, int y)
{
    //Effects: If x==null throw NullPointerException
    // else return the index of the last element
    // in x that equals y.
    // If no such element exists, return -1
    for (int i=x.length-1; i > 0; i--)
    {
        if (x[i] == y)
        {
            return i;
        }
    }
    return -1;
}
// test: x=[2, 3, 5]; y = 2
// Expected = 0
```

```
public static int lastZero (int[] x)
{
    //Effects: if x==null throw NullPointerException
    // else return the index of the LAST 0 in x.
    // Return -1 if 0 does not occur in x
    for (int i = 0; i < x.length; i++)
    {
        if (x[i] == 0)
        {
            return i;
        }
    }
    return -1;
}
// test: x=[0, 1, 0]
// Expected = 2
```

Figure 1: Program one and two

```

public int countPositive (int[] x)
{
    //Effects: If x==null throw NullPointerException
    // also return the number of
    // positive elements in x.
    int count = 0;
    for (int i=0; i < x.length; i++)
    {
        if (x[i] >= 0)
        {
            count++;
        }
    }
    return count;
}
// Test: x=[-4, 2, -1, 2]
// Expected = 2

```



```

public static int oddOrPos(int[] x)
{
    //Effects: If x==null throw NullPointerException
    // else return the number of elements in x that
    // are either odd or positive (or both)
    int count = 0;
    for (int i = 0; i < x.length; i++)
    {
        if ((x[i])%2 == 1 || x[i] > 0)
        {
            count++;
        }
    }
    return count;
}
// test: x=[-3, -2, 0, 1, 4]
// Expected = 3

```

Figure 2: Program three and four

Q4 Use the following program fragment to answer the questions below

[1.5*4=6 Marks]

w = x;	// node 1
if (m > 0)	
{	
w++;	// node 2
}	
else	
{	
w=2*w;	// node 3
}	
// node 4 (non executable statement)	
if (y <= 10)	
{	
x = 5*y;	// node 5
}	
else	
{	
x = 3*y+5;	// node 6
}	
z = w + x;	// node 7

1. Draw a control flow graph for this program fragment. Use the node numbers given above.
2. Which nodes have defs for variable w?
3. Which nodes have uses for variable w?
4. Enumerate all of the du-paths for variables w and x.

C2: Quiz-1: Database Management Systems (DBMS)

Session: Jan-July 2023, B.Tech(I.T.), Section-B

Date: 31-March-2023; Duration of Exam: 1 Hour

Course Instructor: Dr. S. Malty

Full Marks: 60

IMPORTANT INSTRUCTION: You MUST show all steps of your calculations clearly.
Otherwise, you will not get any marks even if your final answer is correct.

- Q. 1. Let, $R(M,N,O,P,Q,R,S)$ and $F = \{ P \rightarrow QS, OP \rightarrow Q, OP \rightarrow R, N \rightarrow MO, M \rightarrow O, O \rightarrow S, MN \rightarrow M \}$.
- Is R in BCNF w.r.t F ? If not, perform a BCNF decomposition. NOTE: Always target the first FD which is violating BCNF condition, for decomposition purpose.
 - Is R in 3NF w.r.t. F ? If not, perform a 3NF decomposition.

$10 \times 2 = 20$ marks

Q. 2. Prove that Armstrong's Axioms are sound.

10 marks

Q. 3. State the definition of multivalued dependency.

5 marks

Q. 4. State the definition of 4NF.

5 marks

Q. 5. Consider the following Project-Advisor schema:-

Advisor(Project_id, instructor_id, student_id, instructor_dept, student_dept)

Where the user imposed the following constraints:-

- Project_id is unique for each project.
- A student can take any number of guides from different departments but cannot take more than one guide from any one department.
- A student must take at-least one guide from his/her own department.
- A faculty can work under only one department but can guide students of other departments.
- A faculty can guide maximum 5 students irrespective of departments.

- Define the set of FDs imposed by the user (for ease of writing, you may assign a letter for every attribute, for instance: A, B, C, D, E for the five attributes of the schema, and denote the schema as R).
- Is the relation in BCNF or 3 NF? Justify your answer.
- Now, if you remove the first attribute (Project_id) from the above schema then do you think that the modified schema would be in BCNF, 3 NF? Justify your answer.
- If you think the answer to the previous question (5.c) is no, then do a 3 NF decomposition of the modified schema.

$10 \times 2 = 20$ marks

END

C2 Review Test (April 2023)

Principles of Programming Languages

Max Marks: 10

Time: 40 minutes

-
- 1) Provide a solution to the producer-consumer problem using semaphores to illustrate both competition and cooperation synchronization.** [5 marks]

 - 2) Give an example of static scoping in languages that allow nested subprograms and show how static scoping is implemented in such languages with the help of this example.** [5 marks]
- * * * * *



Department of Information Technology
Data Structures, C2 Review Test – 5th July, 2022
B.Tech. IT, EC & IB (II semester)

Duration: 2 Hrs. (04:00–06:00 PM)

Maximum Marks: 60

Instruction: All questions are compulsory. Attempt all the subparts of a question together.

Q. 1. Answer the following.

[1 mark each=10]

- i. The total number of structurally distinct strict binary trees with 5 leaf nodes is _____.
- ii. In a binary search tree of height h with root at level 0, the minimum level number possible for a second largest element is _____.
- iii. In order to delete a 2 degree node (p) in a binary search tree, its inorder successor (q) is actually deleted. Which node always takes the place of q?
- iv. In a MAX-HEAP of height h with root at level 0, the minimum valued node is always present at which level number?
- v. The minimum number of leaf nodes in a complete binary tree of height h with root at level 0 is _____.
- vi. If the preorder traversal of a binary search tree is CABDFE, then its postorder traversal will be _____.
- vii. A complete graph is a graph containing an edge between every pair of vertices. How many connected acyclic graphs containing all the vertices are possible in a complete graph of n vertices?
- viii. The time complexity to insert an edge (a,b) in a directed graph stored using adjacency list, when the address to the header node of vertex 'a' is given, is _____.
- ix. Quick sort takes least time when in every pass pivot is selected as the _____ of the data.
- x. The breadth first search of a binary tree when the starting vertex is root will display the _____ traversal of the binary tree.

Q. 2 (a). Given a complete binary tree with exactly 10000 nodes, implemented using an array with starting index at 1. A node value is stored in location 5000. Where is the value stored for this node's parent and its left child? Comment about its right child? [1+1+1=3]

(b). Write a function to compute the number of children of any node in a complete binary tree. [2]

(c). For the set of keys {1, 4, 5, 10, 16, 17, 21}, draw the binary search trees of height 3, 5, and 6. [3]

(d). Is the operation of deletion "commutative" i.e., deleting x and then y leaves the same binary search tree as deleting y and then x? Argue or give a counterexample. [2]

Q. 3 (a). You are given a binary min-heap of height h . What are the minimum and the maximum number of comparisons we might have to do when inserting the next value (in terms of h)? [2]

(b). Illustrate an efficient sorting of heap elements through the concept of min-heap, by deleting two elements at a time where the first element is the maximum and second element is the minimum of the heap. Comment on the time complexity of the sorting. [2+2=4]

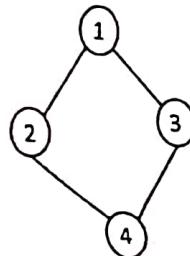
(c). Draw the binary min-heap that results from inserting {11, 3, 2, 15, 4, 25, 6, 8, 1} in that order into an initially empty binary min-heap. You are required to show the intermediate trees with the final tree. [2+2=4]

(d). Draw the result of two delete_min calls on your heap drawn in part (c). [2]

Q. 4 (a). Consider a graph of n nodes and e edges. How much space will be required to store the graph using (i). adjacency matrix and (ii). adjacency list? When the number of edges in the graph is too less (i.e., $e \ll n$) what will be the effect on space requirement in each of these representations? When the number of edges in the graph is too large (i.e., $e \gg n$) what will be the effect on space requirement in each of these representations? [1+1+1+1=4]

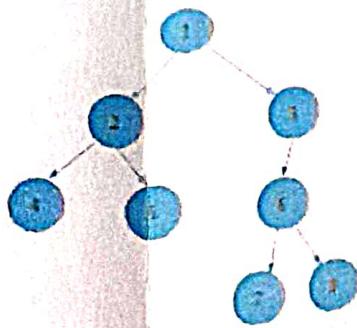
(b). Consider the following pseudocode for DFS

```
void dfs(int i){  
    for each vertex v adjacent to i{  
        print(i);  
        dfs(v);  
    }  
}
```



Show the effect of given code on the above graph by highlighting the problem faced. Eliminate the problem by modifying the pseudocode and estimate the time complexity of the modified pseudocode. [2+2+2=6]

Q. 5. Consider the following binary tree with 8 nodes:



(a). The following code snippet represents the data structure to store the binary tree node. Fill up the blanks to complete the code.

```
// Data structure to store a binary tree node  
typedef struct node_type
```

```
{  
    int key;  
    ----- *left,*right; // Pointers to left and right child  
} node;
```

1] // User defined data type for

```
typedef node *tree // Pointer to root node
```

(b). Assume the tree has been constructed and is available in the memory.

i. Complete the recursive function `postorder(tree temp)` provided below. The function traverses the binary tree in post-order format.

ii. Print the nodes in a sequence as traversed in post-order format.

```
postorder(tree temp) {
    if (temp == NULL) ----;
    else {
        ----
    }
}
```

(c). An alternate way of representing the nodes is a Left-child right-sibling (LC-RS) binary tree.

Each node in the LC-RS binary tree has two pointers: one to the node's left child and one to its next sibling in the original binary tree. So starting with the root, each node's leftmost child in the original tree is made its left child in the LC-RS binary tree, and its nearest sibling to the right in the original tree is made its right child in the binary tree.

[1]

i. Construct the LC-RS tree for the binary tree provided above.

ii. Complete the code that converts a binary tree to its LC-RS form. Fill in the gaps in the code provided below. Try to fill the gaps in the comments as well to understand the conversion procedure.

[2]

```
void convert(--- temp) {
    // base case: empty tree
    if (temp == NULL) {
        ----;
    }
    // recursively convert the left and right subtree first
    -----
    -----
    // if the ---- child is empty, point it to ----
    // and set the ---- child to ----
    if (---- == ----)
    {
        -----
        -----
    }
    // if the ---- child exists, then make its ----
    // point to the current node's ----- and
    // and set the ----- as null
    else {
        -----
        -----
    }
}
```

(d). Traverse the LC-RS tree in such a way that the nodes get printed in the same order as the post-order traversal in the original binary tree representation. Write a recursive function for the above traversal of LC-RS.

[1+2]

(e). Compute the running time (time complexity) of the recursive function

[1]

Q. 6. a. Consider the following method of merging two sorted arrays, arr1[] and arr2[] into arr3[]:

Step 1: Perform a binary search for arr2[0] in the array arr1[]

Step 2: If (arr2[0] is in between arr1[i] and arr1[i+1])
 output arr1[1] through arr1[i] to array arr3
 output arr2[0] to array arr3

Step 3: Perform a binary search for arr2[1] in the sub-array arr1[i+1] to arr1[l-1] // l is number of elements in arr1

Step 4 : Repeat the procedure for every element of array arr2

i. Write a C routine to implement the method and find its time complexity.

[3]

ii. In which case the method performs more efficiently than the merge procedure given below. Explain with an example and compute the time complexity in such a case. In what case the method performs worse. Explain with an example and calculate the time complexity in such a case.

[4]

```
void mergeArrays(int arr1[], int arr2[], int n1, int n2, int arr3[]){
    int i = 0, j = 0, k = 0;
    // Traverse both arrays
    while (i < n1 && j < n2)
    {
        /* Check if current element of first array is
           smaller than current element of second array. If
           yes, store first array element and increment first
           array index. Otherwise do same with second array */
        if (arr1[i] < arr2[j])
            arr3[k++] = arr1[i++];
        else
            arr3[k++] = arr2[j++];
    }

    // Store remaining elements of first array
    while (i < n1)
        arr3[k++] = arr1[i++];
    // Store remaining elements of second array
    while (j < n2)
        arr3[k++] = arr2[j++];
```

(b). Suppose a string is the following list of 14 characters : DAT A S T R U C T U R E S

If the characters in the string have to be sorted alphabetically using quicksort algorithm, find the position of the character D. Show the application of the quicksort algorithm to find the position.

[3]

(End of the Paper)

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY ALLAHABAD

Department of Information Technology

Computer Networks (CN)

B.Tech. (IT) -4th Semester (Section B and C)

Full marks: 80 Marks

Session: JAN-MAY 2023

Duration: 2.0 hrs.

Group-A: All questions are compulsory (16marks):-

A.1	What are Baud Rate and Bit Rate?	2
A.2	Define Frequency and Bandwidth. Given the period of a signal is 100 ms. What is its frequency in kilohertz (kHz)?	2
A.3	Difference between cumulative ACK and independent ACK.	2
A.4	What is the broadcasting address in EATHERNET.	2
A.5	Difference between limited broadcasting and directed broadcasting in network layer.	2
A.6	What is the difference between connectionless and connection-oriented services?	2
A.7	What is the role of ARP and RARP?	2
A.8	Find the range of IP addresses in 200.17.21.128/27	2

Group-B: Each of the following questions contains 8 Marks. (8*8=64 marks):-

B.1	a	Explain clearly the responsibilities and the list protocols for each layer of ISO-OSI reference model. How OSI reference model is different from TCP/IP reference model? List at least three protocols of each layer of TCP/TP reference model.	3
	b	How many bytes of data can be sent in 15 seconds over a serial link with baud rate of 9600 in asynchronous mode with odd parity and two stop bits in the frame?	3
	c	Discuss the advantages and disadvantages of Differential Manchester encoding over NRZ-I.	2
B.2	a	A computer network uses polynomial over GF(2) for error checking with 8 bits as information bits and uses $x^3 + x + 1$ as the generator polynomial to generate the check bits. In this network, how the message 01011011 will be transmitted?	4
	b	Station A needs to send a message consisting of 9 packets to Station B using a sliding window (window size 3) and go-back-n error control strategy. All packets are ready and immediately available for transmission. If every 5th packet that A transmits gets lost (but no acks from B ever get lost), then what is the number of packets that A will transmit for sending the message to B?	4
B.3	a	A packet has arrived with MF (more fragment) bit as 0. Is this the first, middle, or last fragment? Can we say whether the packet was fragmented?	2
	b	A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps ($1\text{Kbps} = 1000 \text{ bits/second}$). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds. Assuming no frame is lost, what is the sender throughput in bytes/second?	4
	c	Discuss the CSMA/CD protocol.	
B.4	a	An organization is granted the block 150.36.0.0/16. The administrator wants to create 512 subnets.	2
	i	Find the number of addresses in each subnet.	
	ii	Find the first and last addresses in subnet 1.	5
B.5	b	Discuss the count to infinity problem associated with Distance Vector Routing.	
	a	Explain in detail the Link State routing algorithm.	3
	b	An IPv4 datagram has arrived with the following information in the header (in hexadecimal): (45 00 00 54 00 03 58 50 20 06 00 00 7C 4E 03 02 B4 OE OF 02) ₁₆ i. Are there any options? ii. Is the packet fragmented? iii. What is the size of the data? iv. How many more routers can the packet travel to?	6

	v. What is the identification number of the packet? vi. What is the type of service?	
B.6	<p>a Discuss the Dynamic Host Configuration Protocol (DHCP). 2</p> <p>b The following is a dump of TCP header in hexadecimal format. $(053200217\ 000000001\ 00000000\ 500207FF\ 00000000)_{16}$</p> <p>i. What is the source port number? ii. What is sequence number? iii. What is the acknowledgement number? iv. What is the length of the header? v. What is the type of the segment? vi. What is the window size? 6</p>	
B.7	<p>a Consider an instance of TCP's Additive Increase Multiplicative Decrease(AIMD) algorithm where the window size at the start of the slow start phase is 2 MSS and the threshold at the start of the first transmission is 8 MSS. Assume that a time out occurs during the fifth transmission. Find the congestion window size at the end of the tenth transmission. 4</p> <p>b Consider an IP packet with a length of 4,500 bytes that includes a 20-byte IPv4 header and 40-byte TCP header. The packet is forwarded to an IPv4 router that supports a Maximum Transmission Unit (MTU) of 600 bytes. Assume that the length of the IP header in all the outgoing fragments of this packet is 20 bytes. Assume that the fragmentation offset value stored in the first fragment is 0. What will be the fragmentation offset value stored in the third fragment? 4</p>	
B.8	<p>a Explain the procedure for checksum calculation and verification in the IPv4 protocol. What part of an IPv4 packet is covered in the checksum calculation? Why? 4</p> <p>b Discuss the SMTP and POP 4</p>	



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Department of Information Technology
Design and Analysis of Algorithms, C3 Review Test
B.Tech. IT & BI (IV semester)

Duration: 2 hrs.

Maximum Marks: 40

Note: All questions are compulsory. All the subparts of a question are to be attempted together.

Q1. Give precise answers for the following. [5]

- Suppose a polynomial time algorithm is discovered that correctly computes the Hamiltonian circuit in a given graph. In this scenario, draw the correct Venn diagram of the complexity classes P, NP and NP-Complete (NPC).
- A problem in complexity class NP can be verified in _____ time.
- Give an example of NP hard problem which is not NP-Complete.
- Compare the two functions $f_1(n) = n$ and $f_2(n) = \cos n$ in terms of the Big-O notation.
- Given array L = [10, 20, 30, 40, 50, 60], state the number of existing elements, which if searched using the Binary search method will require the maximum number of comparisons.

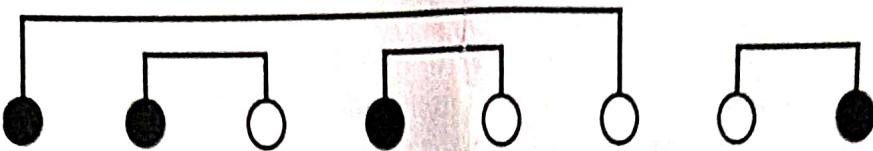
Q2. Answer the following with proper justification. [10]

- Given a list of n cities and the unit distance between each pair of cities, what is the shortest possible route cost that visits each city exactly once and returns to the origin city? How many such shortest routes exist?
- Consider a 3-regular graph (i.e., a graph where every vertex has degree 3) of 8 vertices. State the size of the optimal vertex cover (i.e., a set of vertices that includes at least one endpoint of every edge of the graph).
- There are 25 horses among which you need to find out the fastest 3 horses. You can conduct race among at most 5 to find out their relative speed. At no point you can find out the actual speed of the horse in a race. Find out how many races are required to get the top 3 horses.
- Write two solutions of 4 queens problem (a problem of placing 4 queens on a chess board of size 4×4 such that none of them are at the conflicting positions).
- R_n is defined to be the maximum amount earned by cutting a rod of length n meters into one or more pieces of integer length and selling them. For $i > 0$, let $p[i]$ denotes the selling price of a rod whose length is i meters. Consider the array of prices: $p[1]=1$, $p[2]=5$, $p[3]=8$, $p[4]=9$, $p[5]=10$, $p[6]=15$, $p[7]=18$. Compute R_6 ?

Q3. Find an optimal parenthesization of the matrix product $A_1 A_2 A_3 A_4$ using dynamic programming [5]
whose dimensions are given as

Matrix	A_1	A_2	A_3	A_4
Dimension	13×5	5×89	89×3	3×34

- Q4. There are n white dots and n black dots, equally spaced, in a line. You want to connect each white dot with some one black dot in a one-to-one fashion, with a minimum total length of [5] wire.



The total wire length for the above example is $1 + 1 + 1 + 5 = 8$.

- a. Do you see a greedy algorithm for doing this? How?
- b. Does the algorithm guarantee an optimal solution? If yes then prove it, otherwise give a counter example.

- Q5. Let $G = (V, E)$ be a connected undirected graph with an edge-weight function $w: E \rightarrow R$. Let w_{\min} and w_{\max} denote the minimum and maximum weights, respectively, of the edges in the graph. Do not assume that the edge weights in G are distinct or nonnegative. The following statements may or may not be correct. In each case, either prove the statement is correct or give a counterexample if it is incorrect. [10]

- a. If the graph G has more than $|V| - 1$ edges and there is a unique edge having the largest weight w_{\max} , then this edge cannot be part of any minimum spanning tree (MST),
- b. Any edge e with weight w_{\min} , must be part of some MST.
- c. If G has a cycle and there is unique edge e which has the minimum weight on this cycle, then e must be part of every MST.
- d. If the edge e is not part of any MST of G , then it must be the maximum weight edge on some cycle in G .
- e. Suppose the edge weights are nonnegative. Then the shortest path between two vertices must be part of some MST.

- Q6. Suppose you are given a source string $S[0..n-1]$ of length n , consisting of symbols a and b . Suppose further that you are given a pattern string $P[0..m-1]$ of length $m \ll n$, consisting of symbols a , b , and $*$, representing a pattern to be found in string S . The symbol $*$ is a “wild card” symbol, which matches a single symbol, either a or b . The other symbols must match exactly. The problem is to output a sorted list M of valid “match positions”, which are positions j in S such that pattern P matches the substring $S[j..j+|P|-1]$.
For example, if $S = a b a b b a b$ and $P = a b *$, then the output M should be $[0, 2]$. [5]

Indian Institute of Information Technology
 Software Engineering
 C3 Review Test (B.Tech. IV Semester)

Instructions: If required, make necessary assumptions and clearly mention them.

[90 Mins]

Q1: Consider yourself in the role of a software designer, who is scheduled for a meeting with a client. You were informed about the meeting at the last minute and at this meeting you are expected to present an early prototype of a Library application design. As it happens, the client had some basic familiarity with programming, and the client insisted upon using OOPs in the application development. So, you quickly prepared a design draft, shown in Table 1, and proceeded for the meeting. It is when you start explaining functionality of each class to the client, you notice small issues related to good design and functional completeness.

List and describe the issues you observe for the design shown in the table for each class separately(if any). Further, suggest the minimal changes that would improve the design or will mitigate the functional incorrectness/incompleteness in the application.

3 Marks

Class Element \ Class Name	LibraryCard	Manager	Cart	SecurityPersonal
Attributes or Fields	- id : String + mycart : Cart	- id : String		- id : String
Behavior or Methods	+ deposit(mycart) + issue(mycart)	+ manage()	+ add() + remove() - get()	+ open() + close() + exitCheck()

Table 1: An early design for a Library application prototype

Q2: Analyze each of the following scenarios, and name and discuss the benefits of underlying architectural style used. Further, describe if monolithic architecture is used then how it will affect the software developers and the users.

- Scenario 1** A base software can be extended by adding a third party program to it. The extension requires the user of base software to specify details in a *xml* file and reboot the base software. The base software reads the description *xml* and allows users to interact with the third party program from its designated interface.
- Scenario 2** A software is divided into multiple components and these components were developed, maintained, and installed separately. These components interacted via messages.

0.75x2 + 0.75x2 Marks

Q3: Describe two applications such that for one *security* is crucial but *scalability* is not, whereas for the other *scalability* is crucial but *security* is not.

2 Marks

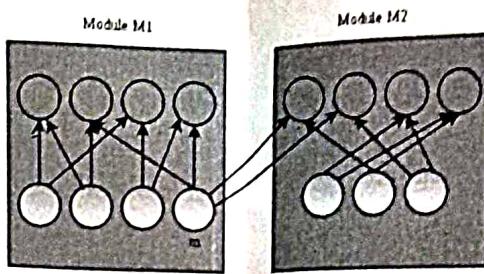
Q4: Match the problem domains in GROUP I with the solution technologies in GROUP II. For each matching justify your answers in 2-3 lines.

1 Marks

GROUP I	GROUP II
(P) Service-oriented computing	(1) Interoperability
(Q) Heterogeneous communicating systems	(2) BPMN
(R) Information representation	(3) Publish-find-bind
(S) Process description	(4) XML

Q5: The following figure represents access graphs of two modules M1 and M2. The filled circles represent methods and the unfilled circles represent attributes. If method m is moved to module M2 keeping the attributes where they are, what can we say about the average cohesion and coupling between modules in the system of two modules? That is which of them (Cohesion and Coupling) will increase and which one will be reduced? Justify your answer.

3 Marks



Q6: A company needs to develop digital signal processing software for one of its newest inventions. The software is expected to have 40,000 lines of code. The company needs to determine the effort in person months needed to develop this software using the basic COCOMO model. The multiplicative factor for this model is given as 2.8 for the software development on embedded systems, while the exponentiation factor is given as 1.20. What is the estimated effort in person months?

2 Marks

Q7: The following program is to be tested for statement coverage:

{

```

if (a == b) {S1; exit;}
else if (c == d) {S2;}
else {S3; exit;}
S4;
}

```

The test cases T1, T2, T3 and T4 given below are expressed in terms of the properties satisfied by the values of variables a, b, c and d. The exact values are not given. T1 : a, b, c and d are all equal T2 : a, b, c and d are all distinct T3 : a = b and c != d T4 : a != b and c = d Which of the test suites given below ensures coverage of statements S1, S2, S3 and S4?. Give justification and explanation to your answer

3 Marks.

1. T1,T2,T3

2. T2,T4

3. T3,T4

4. T1,T2,T4

Q8: Compute the Cyclomatic Complexity for the C-Program shown below.

3 Marks

```

while (first <= last)
{
    if (array [middle] < search)
        first = middle + 1;
    else if (array [middle] == search)
        found = True;
    else last = middle - 1;
    middle = (first + last)/2;
}
if (first < last) not Present = True;

```