B.Sc. (Honours) Examination, 2021
Semester – IV
Subject: Computer Science
Course: CC8
Design and Analysis of Algorithms (Theory)

Time: 3 Hours **Full Marks: 40**

Answer **Question No. 1** and any ***four*** from the rest.

1. a) What is divide and conquer strategy? How does it differ from dynamic programming?
   b) Explain all asymptotic notations.
   c) Solve the following recurrence relation to find T(n) where $T(n) = \Theta(1)$ if $n = 1$ and $6T(n/2) + \Theta(n^2)$ if $n > 1$. [2+3+3=8]

2. a) How quickly can you multiply a $kn \times n$ matrix by an $n \times kn$ matrix, using recursive matrix multiplication algorithm as a subroutine? Analyse the time complexity of your algorithm.
   b) By applying the above algorithm multiply the following two matrices:
   $\begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \\ 7 & 8 \\ 9 & 0 \\ 1 & 2 \end{bmatrix}$ and $\begin{bmatrix} 1 & 3 & 5 & 7 & 9 & 1 \\ 2 & 4 & 6 & 8 & 0 & 2 \end{bmatrix}$. [4+4=8]

3. a) What is k-ary maxheap? Write an algorithm to find all the children of a parent node p for a k-ary heap and vice versa.
   b) Apply a 3-ary heapsort algorithm to sort the following list of numbers: 44, 66, 99, 88, 11, 22, 66, 77, 22, 33, 77, 88. Show all the steps. [4+4=8]

4. a) What do you mean by matrix chain multiplication problem?
   b) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is ‹5, 10, 3, 12, 5, 50, 6›. Show all the steps. [2+6=8]

5. a) Describe and analyse quicksort algorithm.
   b) Use this algorithm to sort a list of numbers given below:
   67, 56, 78, 98, 23, 54, 77, 12, 80, 34. [4+4=8]

6. a) Let G = (V, E) be a connected, undirected graph. Give an O(V + E) time algorithm to compute a path in G that traverses each edge in E exactly once in each direction.
   b) Write an algorithm to merge to sorted arrays. Analyse its time complexity. [4+4=8]

7. a) Create a Red-Black tree for the dataset 93, 89, 67, 33, 65, 21, 55, 90, 89, 20. Explain all the steps. Now delete the element 90.
   b) Suppose you have a sorted list of elements. Write an algorithm to insert an element in its proper position. Analyse its time complexity. [5+3=8]

B. Sc. Semester -IV, Examination 2021
Software Engineering
CC -9 (Theory)

ime: 3 hours
Full marks: 40

All questions are of equal marks

Answer any four

1. Define SRS. What are the characteristics of SRS? What do you understand by a good SRS document? Explain the significance of requirement analysis in SRS document preparation. 2+3+3=10

2. Why do we need SDLC models? With the help of diagram explain spiral model. Give a comparative study between prototype model and spiral model. 2+3+5=10

3. What do you understand by software process activities? Explain the importance of umbrella activities in software process development. What is the difference between framework activities and umbrella activities? 2+5+3=10

4. Explain Waterfall Model. What are the problems that are sometimes encountered when the waterfall model is applied? 5+5=10

5. Explain the Evolutionary and Incremental Model. What are the Advantages and Disadvantages? Define Verification and Validation. 3+3+4=10

6. Write short notes on (any two): 5+5=10

   I. Black box testing vs. White box testing
   II. Cyclomatic complexity
   III. COCOMO Model

B.Sc. Examination, 2021
Semester-IV
Computer Science
Course: CC-10 (Theory)
(Database Management System)

Time: 3 Hours Full Marks: 40

Questions are of value as indicated in the margin.
Answer **Question No. 1** and **any four** from the rest.

1. a) Write down the differences between super key and candidate key.
b) Differentiate between the "*where*" and "*having*" clauses in SQL.
c) Let *r* (R) and *s* (S) are two relations with 50 and 100 tuples, respectively. If $R \cap S = \Phi$, then what would be the number of tuples in $r \bowtie s$?
d) Write two uses of the attribute closure.
$4 \times 2 = 8$

2. Consider the following employee database:
employee (emp id, name, street, city)
works (emp id, company_name, salary)
Consider the following queries:
i) Find the names of all employees and the companies they work for.
ii) Find the number of employees in each company whose salaries are greater than or equal to Rs. 50,000.
iii) Find the names and cities of residence of all employees whose salaries are greater than or equal to Rs. 75,000.
Answer the following questions:
a) Write an expression in SQL for each of the query in (i), (ii), and (iii).
b) Write an expression in relational algebra for each of the query in (i), (ii), and (iii).
c) Write an expression in tuple relational calculus, and domain relational calculus for the query in (i).
3+3+2=8

3. a) How is 3NF advantageous over BCNF?
b) Let the schema R = (A, B, C, D) has been decomposed into R1 = (A, B, C) and R2 = (C, D). Justify whether the decomposition is lossless with the following set F of functional dependencies:
$A \rightarrow B,\ A \rightarrow C,\ C \rightarrow D$
c) Normalize the following schema, with the given constraints, into BCNF.
books(accessionno, isbn, title, author, publisher)
users(userid, name, deptid, deptname, accessionno)
{accessionno → isbn, isbn → title, isbn → publisher, isbn → author, userid → name, userid → deptid, deptid → deptname}
2+3+3=8

4. Consider the following set F of functional dependencies on the relation schema r (A, B, C, D, E, F): {A → BCD , BC → DE , B → D , D → A}
a) Compute B^+.
b) Show that AF is a super key.
c) Compute a canonical cover for the above set of functional dependencies F.
2+2+4=8

B.Sc. (Honours) Examination, 2019
Semester-IV
Computer Science
Course : CC-8
(Design and Analysis of Algorithms)

3 Hours **Full Marks : 40**

Questions are of value as indicated in the margin

Answer Question No.1 and **any four** from the rest

Define asymptotic tight bound, asymptotic upper bound, and asymptotic lower bound.
What is the time complexity of the following code:

```
main()
{
    int i, j, k, p, n;
    S(p), S(n); // scan
    for i = 1 to p
        for j = n/p to n
            for k = 1 to p^n changed by k* = p;
}
```

Prove that in a full binary tree the number of leaf nodes is $\frac{n+1}{2}$ when n is the total number of nodes.

Define red-black tree. 3+1+2+2=8

Explain Divide and Conquer method.

Solve the following recurrence relation by recursion tree method:

$T(n) = \Theta(1)$ if $n = 1$ and $aT(n/b) + c$ if $n = b^p$,

where $T(n)$ is a positive function of n, p is a positive integer, $a \geq 1, b > 1, c \geq 1$, and a, b, c are constants.

Write an algorithm to multiply two matrices (or, to solve 3-way merge sort) by divide and conquer method. Analyse the time complexity of the solved problem. 1+3+(3+1)=8

Apply radix sort algorithm to solve the following list of elements:

9, 800, 596, 323, 9, 23, 509, 323, 700.

How is quicksort algorithm used to sort a list of numbers in non-increasing order? Show all the steps.

Analyse its time complexity.

Execute the above algorithm to sort a list of numbers mentioned in $3(a)$. 2×4=8

How does DFS algorithm work? Show all the steps.

Consider a graph G having 6 vertices and 8 edges represented by the following adjacency matrix:

P.T.O.

	1	2	3	4	5	6
1	0	1	0	1	0	0
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	1	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	0	0	1

Apply DFS traversal on the above graph by taking 1 as the starting vertex.

c) Define tree edge, forward edge, back edge and cross edge.

d) Show all the edges on the graph mentioned in $4(b)$.

5. a) Let $A_1, A_2, ..., A_n$ be n matrices of orders $p_1 \times p_2, p_2 \times p_3, ..., p_n \times p_{n+1}$, respectively. Write an algorithm to parenthesize $(A_1 \times A_2 \times ... \times A_n)$.

b) Illustrate all the steps for the matrices A_1, A_2, A_3, A_4, and A_5 having the orders 5×10, 30×100, 100×5, and 5×20, respectively.

c) After solving $5(b)$, is it possible to parenthesize $(A_2 \times A_3 \times A_4)$? Justify your

6. a) Define $p-$ ary maxheap.

B.Sc. (Honours) Examination, 2019
Semester-IV
Computer Science
Course : CC-10
(Database Management System)

Full Marks : 40

3 Hours Questions are of value as indicated in the margin

Answer Question No.**1** and **any three** from the rest

2×5=10

wer any five questions:

How natural full outer join can be used to preserve lossless join property?

What are stored and derived attribute?

How primary key is different from the alternate key?

Explain specialization and generalization concepts in ER diagram with suitable examples.

What is the function of Query Evaluation Engine?

Explain different types of participation constraint.

With examples define DDL and DML.

ted Parcel Service (UPS) is an American multinational package delivery and supply chain nagement company. UPS prides itself on having up-to-date information on the processing current location of each shipped item. To do this, UPS relies on a company-wide rmation system. Shipped items are the heart of the UPS product tracking information em. Shipped items can be characterized by item number (unique), weight, dimensions, irance amount, destination, and final delivery date. Shipped items are received into the UPS em at a single retail center. Retail centers are characterized by their type unique ID, and ress. Shipped items make their way to their destination via one or more standard UPS nsportation events (i.e. flights, truck deliveries). These transporation events are characterized a unique Schedule Number, a type (e.g, flight, truck), and a Delivery Route.

sign an ER diagram and schema to a capture the above requirements. State any assumption have that affects your design. Make sure cardinalities and primary keys are clearly ntioned. 10

nsider the following relations:

om (roomno:integer, capacity:integer, price:real)

enity (aid:integer, name:string, description:string)

om Amenities (roomno:integer, aid:integer)

est (sin:integer, fname:string, lname:string, dob:date)

servations (sin:integer, roomno:integer, resdate:date)

sdate' in the Reservations relation refers to the date for which a room is booked by a ticular guest.

guest books a room for multiple consecutive days, then a separate tuple will appear for each e the room has been booked for by that guest.

ite the relational algebra and SQL expressions for the following queries:

Find the room number and capacity of rooms that have price less than Rs. 2500.

Find the name of amenities offered in rooms on the 4th floor. You may assume that rooms on the 4th floor have room numbers between 400-499. Make sure that each amenity is listed at most once.

P.T.O.

c) Find the room number and price of rooms that have *Air-Conditioning* and [illegible] booked for *11-JUN-2015* by at least one guest.

d) Find the first and last names of senior guests (guests with age 65 or higher) [illegible] on the 4th floor (i.e., rooms 400-499) on any date between 4-JUN-2015 and [illegible]

4. a) Consider a relation scheme $R = (A, B, C, D, E, H)$ on which the following dependencies hold: $\{A \rightarrow B, BC \rightarrow D, E \rightarrow C, D \rightarrow A\}$. What are the candidate keys of R?

b) Given a relation $S(A, B, C, D, E, F, G)$ with the set of functional dependencies $F = \{A \rightarrow BC, E \rightarrow CF, B \rightarrow E, CD \rightarrow EF, A \rightarrow G\}$. Find the closure and canonical cover for F.

5. Write short note on the following topics (**any two**) :
   a) Integrity Constraints,
   b) ODBC,
   c) Nested Relational Model,
   d) Rename Operation

6. Describe and illustrate the process of normalizing the relation shown in Table 1 up to [illegible] any assumptions you make about the data shown in this table.

Pet id	Pet name	Pet type	Pet age	Owner	Visit date	Procedure
246	rover	dog	12	sam cook	jan 13/2002 mar 27/2002 apr 02/2002	01-rabies vaccinati 10-examine and tre 05-heart worm test
298	spot	dog	2	terry kim	jan 21/2002 mar 10/2002	08-tetanus vaccinat 05-heart worm test
341	morris	cat	4	sam cook	jan 23/2001 jan 13/2002	01-rabies vaccinati 01-rabies vaccinati
519	tweedy	bird	2	terry kim	apr 30/2002 apr 30/2002	20-annual check up 12-eye wash

Table 1 : Pet Health History Report

Separate Answer for each Unit

Undergraduate Examination 2019

Semester – IV (CBCS)

Mathematics

Generic Elective Course: GEC-4

(Linear Programming Problem and Numerical Methods)

Three Hours **Full Marks: 60**

Questions are of value as indicated in the margin.
Notations and symbols have their usual meanings.

UNIT-I [Linear Programming Problem (Marks: 30)]

Answer ***any three*** questions.

Find the basic solutions of the set of equations
$2x_1 + 4x_2 - 2x_3 = 10,$
$10x_1 + 3x_2 + 7x_3 = 33.$ 4

When an L.P.P. has (i) no feasible solution, (ii) unbounded solution? 2

Given $x_1 = 1,\ x_2 = 3,\ x_3 = 2$ is a feasible solution of the equations
$2x_1 + 4x_2 - 2x_3 = 10,$
$10x_1 + 3x_2 + 7x_3 = 33.$
Reduce the above feasible solution to a basic feasible solution by reduction theorem. 4

Prove that convex polyhedron is a convex set. 4

Examine if $S = \{(x, y) \in \mathbb{R}^2 : x^2 + y^2 \le 25\}$ is a convex set. Find its extreme points, if any. 3+1

Give an example with justifications of a non-convex set. 2

Solve graphically the L.P.P.

Minimize, $z = -2x_1 + x_2$

Subject to
$x_1 + x_2 \ge 6,$
$3x_1 + 2x_2 \ge 16,$
$x_2 \le 9,\ x_1 \ge 0,\ x_2 \ge 0.$ 4

Solve by simplex method the L.P.P.

Maximize, $z = x_1 + 2x_2$

Subject to
$x_1 - 5x_2 \le 10,$
$2x_1 - x_2 \ge 2,$
$x_1 + x_2 = 10,\ x_1 \ge 0,\ x_2 \ge 0.$ 6

Prove that for a primal L.P.P. dual of the dual is the primal itself. 4

Solve the problem

Minimize, $z = 3x_1 + x_2$

Subject to
$2x_1 + x_2 \ge 14,$
$x_1 - x_2 \ge 4,\ x_1 \ge 0,\ x_2 \ge 0.$

by solving its dual problem with the help of simplex method. 2+4

P.T.O.

5. a) Find the dual of the problem

Maximize, $z = 2x_1 + x_3$

Subject to

$4x_1 - 5x_2 + x_3 = 0,$

$x_1 + 2x_2 + 3x_3 \le 7,\ x_1 \ge 0,\ x_2 \ge 0,$

where x_3 is unrestricted in sign.

b) Solve the following balanced T.P. by using VAM to determine the initial B.F.

	D_1	D_2	D_3	D_4	a_i
O_1	4	2	7	-1	27
O_2	3	0	2	4	33
O_3	5	3	4	5	23
O_4	3	5	4	-2	17
b_j	31	24	25	20	100 / 100

UNIT-II [Numerical Methods (Marks: 30)]

Answer ***any three*** questions.

1. a) Obtain the general formula for estimating relative error of a function of n variables.
   b) When does the significant error arises leading to a inaccurate value?
   c) If $\Delta r = \Delta h = 0.01$, find the absolute and relative errors correct upto two significant figures for $V = \frac{1}{3}\pi r^2 h$, when $r = 2$ and $h = 3$.
   d) Find the number of significant figures in
      i) $V_A = 0.3941$ given the absolute error as 0.25×10^{-2}
      ii) $V_T = 1.5975$ given the relative error as 0.1×10^{-2}

2. a) Establish Newton's forward interpolation formula without error term.
   b) Find the missing figure in the following table:

x	16	18	20	22	24	26
$f(x)$	39	85	—	151	233	388

   c) If $f(x) = e^{ax}$, then show that $f(0), \Delta f(0), \Delta^2 f(0)$ are in geometric progression.

3. a) If $f(x) = \sin x$, then show that $\Delta^2 f(x) = -\left(2\sin\frac{1}{2}\right)^2 E f(x)$, taking $h = 1$.
   b) Show that the sum of the Lagrangian function is unity.
   c) Using the suitable interpolation formula find the polynomial which passes through the points $(-1,9), (0,5), (2,3)$ and $(5,15)$.

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Derive composite Simp

Evaluate $\int_0^{\frac{\pi}{4}} \sqrt{\cos x^2}\, dx$

i) Trapizoidal rule
ii) Simpson's one-thi

Find the condition
solution of an algebra
Find the real root of
Solve the equation
3 significant figures
Describe briefly G
equations.

Derive composite Simpson's one-third rule for the numerical integration $\int_a^b f(x)\,dx$. 5

Evaluate $\int_0^{\frac{\pi}{2}} \sqrt{\cos x^2}\,dx$, correct upto 4 decimal places taking 10 intervals by

i) Trapizoidal rule

ii) Simpson's one-third rule. 5

Find the condition of convergence of the fixed point iteration method for the solution of an algebraic or transcendental equation. 3

Find the real root of the equation $3x - \cos x - 1 = 0$ by Newton-Rapson method. 2

Solve the equation $x^3 - 9x + 1 = 0$ for the root lying between 2 and 3, correct to 3 significant figures. 2

Describe briefly Gauss-Jacobi method for solving a linear system of algebraic equations. 3

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separate answer
pts for each Unit

B.A./B.Sc. (Honours) Examination, 2018
Semester-IV
Mathematics (Allied)
Course: BMA-41

: Four Hours **Full Marks: 60**

Questions are of value as indicated in the margin.

Unit-I (Marks-32)
(Linear Programming Problem)
Answer ***Question No. 1*** and ***Three*** from the rest.

Answer any two questions:

i) Are the vectors (1,2,3) and (4,8,12) linearly dependent? Justify your answer. 2×1=2

ii) State 'Fundamental theorem of L.P.P.'.

iii) If X be the set of eight vertices of a cube, then find the convex hull $C(X)$ of the set X.

1) Food X contains 6 units of vitamin A and 7 units of vitamin B per gram and costs 12p/gm. Food Y contains 8 units and 12 units of A and B per gram respectively and costs 20 p/gm. The daily requirements of vitamin A and vitamin B are atleast 100 units and 120 units respectively. Formulate the above problem as an L.P.P. to minimize the cost. 5

b) Solve the following L.P.P. graphically :

Minimize $z = 4x_1 + 2x_2$

subject to $x_1 + 2x_2 \geq 2$

$3x_1 + x_2 \geq 3$

$4x_1 + 3x_2 \geq 6$

$x_1, x_2 \geq 0.$ 5

a) Write a general L.P.P. in its standard form. Rewrite the following L.P.P. in its standard form with non-negative variables.

Maximize $z = 3x_1 + 2x_2 + 5x_3$

subject to $2x_1 - 3x_2 \leq 3$

$4x_1 + 2x_2 - 3x_3 \geq 5$

$2x_1 + 3x_2 \leq 2$ 1+3

$x_1, x_2 \geq 0$; x_3 is unrestricted in sign.

b) Define a linearly independent set of vectors. Are the vectors (1,1,0), (3,0,1) and (5,2,1) linearly independent. Justify your answer. 1+3

c) Consider the set of points on the union of the half line $x = 0,\ y \geq 0;\ \ y = 0,\ x \geq 0$ on xy-plane. Verify whether the set is convex or not. Find the convex hull of the set. 1+1

a) Obtain the basic feasible solutions of the system of equations

$x_1 + 4x_2 - x_3 = 5,$

$2x_1 + 3x_2 + x_3 = 8.$ 4

b) Show that the set of all feasible solutions of an L.P.P. is a convex set. 3

c) If x_1, x_2 be reals, then show that the set given by $X = \{(x_1, x_2) : x_1 + 2x_2 = 5\}$ is a convex set. 3

P.T.O.

5. a) Solve the following LPP by simplex method:

Minimize $z = 3x_1 - 2x_2$

subject to $4x_1 + x_2 \le 8$

$5x_1 + 4x_2 \le 20$

$x_1, x_2 \ge 0.$

b) Solve the following LPP by Big M-method:

Maximize $z = 3x_1 + 2x_2$

subject to $2x_1 + x_2 \le 2$

$3x_1 + 4x_2 \ge 12$

$x_1, x_2 \ge 0.$

6. a) Find the basic feasible solution of the following transportation problem
Common method:

	D_1	D_2	D_3	D_4	D_5	a_i
O_1	2	11	10	3	7	4
O_2	1	4	7	2	1	8
O_3	3	9	4	8	12	9
b_j	3	3	4	5	6	

(b) Determine an initial basic feasible solution of the following transportation
Vogel's approximation method:

	D_1	D_2	D_3	D_4	a_i
O_1	21	16	25	13	11
O_2	17	18	14	23	13
O_3	32	27	18	41	19
b_j	6	10	12	15	

Unit-II (Marks-28)

(Numerical Methods)

Answer ***any four*** questions.

7. a) Define Absolute error and Relative error.

b) Show that the relative error of the product of n numbers is less than or equal
of the relative errors of each numbers.

c) If $f(x) = 4\cos x - 6x$, find the relative percentage error in $f(x)$ at $x=1$,
in $x = 0.005$.

d) If N be a function of five different measurable quantities u, v, w, x, y
$N = \frac{U^p V^q W^r}{X^s Y^t}$, then find an upper limit to the relative error in the meas

8. a) If $f(x)$ be a polynomial of degree n, then the nth difference of $f(x)$
and $(n+1)$ th difference is zero.

b) If $f(x) = \sin x$, then $\Delta^2 f(x) = -\left(2\sin\frac{1}{2}\right)^2 Ef(x)$, taking $h = 1$.

c) Find the missing figure in the following 2

x	0	5	10	15	20
$f(x)$	1	3	9	-	81

a) Establish Lagrange's interpolation formula. 2

b) Show that the sum of Lagrangian functions is unity. 2

c) Find by suitable interpolation formula, the value of $f(2.5)$ and $f(5.5)$ from the following data: 3

x	2	3	4	5
$f(x)$	14.5	16.3	17.5	18.0

a) Derive Simpson's one-third composite rule for the numerical integration $\int_a^b f(x)dx$. 3

b) Evaluate $\int_0^1 \sin x^2 dx$, correct upto 4-decimal places, taking 10 intervals, by

(i) Trapezoidal rule, (ii) Simpson's one-third rule. 4

a) Describe the fixed point iteration method for computing a simple root of an equation $f(x)=0$. 2

b) For finding the fifth root of 'a' $(a>0)$, derive the iteration formula 2

$$x_{n+1}=\frac{1}{5}\left[4x_n+\frac{a}{x_n^4}\right].$$

c) Find the real root of the equation $3x-\cos x-1=0$, by the Newton-Raphson method. 3

Describe briefly Gauss-Jacobi method for solving a linear system of algebraic equation. Using this method obtain solutions correct upto two decimal places for the following equations: 7

$$x-4y+10z=23,\quad 20x+5y-2z=14,\quad 3x+10y+z=17.$$

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