Visva-Bharati
M. Sc Examination 2025
Semester – IV
Computer Science
Course: MCSC – 41 (Image Processing and Computer Vision)

Time: 3 hours **Full Marks: 40**

Questions are of values indicated in the margin
Answer question 1 and any four from the rest

1. Programming experiments during the session.

08

2. Explain the significance of frequency domain representation of a digital image, specifying the significance of a kernel used in transforming a digital image from spatial domain to frequency domain and back. If F(u, v) is the Fourier Transform of an image f(x, y) of size N × N, show that F(u, v) = F(u, v + N) = F(u + N, v) = F(u + N, v + N).

4 + 4 = 08

3. Explain – (i) First order neighbourhood, (ii) Second order neighbourhood of a pixel, with suitable figures for both. How many pixels are involved in the First order neighbourhood of a – (i) Corner pixel, (ii) Non-corner boundary pixel and (iii) Interior pixel? Justify with appropriate figures. Explain how adjacency is different from neighbourhood.

(1 + 1) + 3 + 3 = 08

4. What is the image histogram? Discuss how the histogram information of a gray image is used to obtain probability function of the gray values in the image. Explain the differences between histogram equalization and histogram stretching with a suitable example.

1.5 + 1.5 + 5 = 08

5. Explain – (i) Mean filtering, (ii) Median filtering and (iii) Mode filtering with suitable examples. Specify the influence of order of neighbourhood on the PSNR values of filtered images derived. Explain the role of a mask in the filtering process.

(2 + 2 + 2) + (1 + 1) = 08

6. Explain the process of image registration with a suitable example.

08

7. Write short notes on any two:
   (a) Discrete Cosine Transform.
   (b) Challenges in Computer Vision.
   (c) Use of convolution in digital image processing.

4 × 2 = 08

M.Sc. Examination, 2025
Semester-IV
Computer Science
Course: MCSC-42
(Advanced DBMS)

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. Answer **any four** of the following:
a) Differentiate between primary and secondary indices.
b) Differentiate between relational-algebra expression and query-execution plan.
c) What is left-deep join order? Give an example.
d) What is the isolation property of transactions?
e) What is sublinear speedup in parallel systems?
f) How do you reconstruct the original relation after the vertical fragmentation?

2×4=8

2. a) Consider the following concurrent schedule of transactions T_1, T_2, and T_3. Draw the precedence graph and answer with justification, whether the schedule is conflict serializable, view serializable, and recoverable.

T_1: Read(A), Write(A); T_2: Read(A); T_1: Read(B); T_2: Read(B); T_3: Write(B), Commit; T_1: Write(B), Commit; T_2: Commit.

b) How do you determine serializability order from the precedence graph of transactions for the conflict serializable schedule? Explain with an example.

(1+1.5×3)+2.5=8

3. a) Consider the same schedule of transactions in question no. 2(a). Answer with justification whether the schedule may be generated with 2PL, timestamp-ordering, and Thomas' write rule protocols. Assume $TS(T_1) < TS(T_2) < TS(T_3)$.
b) Suppose there is a crash with the following log:

<T_0 start> <T_0, B, 2000, 2500> <T_1 start> <checkpoint {T_0, T_1}> <T_1, C, 800, 900> < T_1 commit> <T_2 start> <T_2, A, 500, 600> <T_0, B, 3000>.

Briefly explain what would happen during the recovery process.

(1.5×3)+3.5=8

4. a) Derive the cost of selection operation with secondary B+ tree index, having equality on a nonkey attribute.
b) Suppose you have a file with 9,000 pages, and you have three buffer pages. Answer the following questions using the external merge sort algorithm. How many runs will be produced in the first pass? How many passes will it take to sort the file completely? What is the total I/O cost of sorting the file?
c) Show that, with n relations, there are $(2(n-1))!/(n-1)!$ different join orders.

2+(1+1+2)+2=8

5. a) Derive an estimate for the cost of $r(R) \bowtie s(S)$ when $R \cap S$ is neither a key in $r(R)$ nor in $s(S)$.
b) Consider the following schema of the instructor relation in a university:

instructor(ID, name, dept_name, salary).

There are 2,000 instructors and 50 departments in the university. The minimum and maximum salaries are Rs. 50,000 and Rs. 250,000, respectively. Assume the blocking factor ($f_{instructor}$) of the relation is 100. Estimate the cost of the following query in terms of the number of block transfers

from the disk:

$\sigma_{salary >= 100,000 \wedge dept\_name = Computer\ Science}$ (*instructor*).

c) Briefly explain the heuristics-based query optimizer. 2+3+3=8

6. a) Briefly explain a parallel algorithm for natural join.

b) What kind of partitioning technique is suitable for the following query and why?

SELECT *name, salary*
FROM *instructor*
WHERE *dept_name* = 'Computer Science';

c) What is the blocking problem of the two-phase commit protocol? How does the three-phase commit protocol resolve this problem? 3+2+3=8

7. Write short notes on **(any two):**

a) Hybrid Merge Join.

b) Equivalence rules on relational-algebra expressions.

c) Parallel database architectures.

d) Semijoin Strategy. 4×2=8

M.Sc. Examinations, 2025
Computer & System Sciences
Semester – IV Paper: MCSC 43
(Parallel Algorithms)

Time – Three hours **Full Marks-40**

Questions are of marks as indicated in the margin
Answer any four questions

1. a) Given a matrix $A=(a_{ij})_{nXn}$ and a vector $x=[x_1,x_2,...x_n]$, present a parallel algorithm on a PRAM to find the product Ax using p processors.

b) Obtain the time complexity of the algorithm.

c) What type of PRAM is required to execute the algorithm. 6+3+1=10

2. a) Present a parallel algorithm to multiply two nxn matrices on a SIMD hypercube in O(log n) time.

b) Prove that the time complexity of the algorithm above is O(log n). 6+4 =10

3. a) Describe a recursive parallel algorithm to compute the prefix sum of a sequence of n numbers on a PRAM.

b) Obtain the time complexity of the above mentioned parallel algorithm.

c) Does the algorithm require concurrent read/write? Justify your answer. 6+2+2=10

4. a) Present a divide and conquer parallel algorithm on a PRAM to compute the convex hull of a set n points in a plane.

b) Obtain the time and processor complexity of the parallel algorithm.

c) Does the algorithm require concurrent read/write.? 6+2+2=10.

5. a) Present a parallel algorithm on a PRAM to convert a tree to a rooted tree.

b) Present a parallel algorithm on a PRAM to find the post order traversal of a rooted ordered tree.

c) Does the algorithm in b) require concurrent read/write? Justify your answer. 5+3+2=10

6. a) Present the O(log n) time odd even merging network to merge two sorted sequences into a single sorted sequence.

b) Prove that the network correctly by sorting all elements.

c) Obtain the time and processor complexity of the algorithm. 5+3+2=10

Department of Computer & System Sciences

M.Sc Examinations 2025

Semester IV

Quantum Computing (MCSO-15)

Full Marks 40 Time three hours

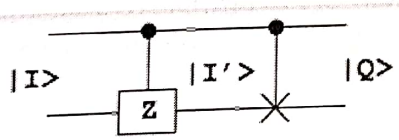
Answer question No. 1 and any four from the rest.

1. Answer any four from the following 4x2=8
   i. State and Explain No-Cloning theorem. Why it is so important in case of Quantum Cryptography?
   ii. What are Quantum Entangled states? Give examples.
   iii. What do you understand by Universal Quantum gate? Explain with example.
   iv. Explain the operation of two quantum gate which does not have any classical analogue.
   v. What are the information available from a qubit?

2.
   i. What is a Unitary Matrix? Prove that CNOT gate is a Unitary operator.
   ii. Prove that X, Y and Z are unitary and $X^2 + Y^2 + Z^2 = -iXYZ$
   iii. Find out the value of $H|+> \; and \; H|->$
   iv. Calculate the value of XYX.

4x2=8

3. Give the matrix representation of the following quantum circuit. Prove that the matrix is unitary.



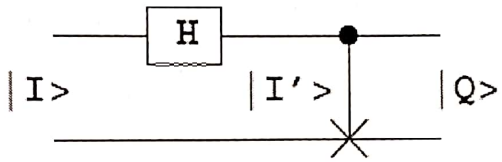
8

4. a.Consider the 2-qubit state $|\varphi> = \; a|00> + b|01> + c|10> + d|11>$ find the value of $p\,(1) \; and \; p(00)$.
   b. If we do some random measurement at the first qubit of the above wave function and it is set to 1 then what would be the post measurement state.
   c. After that measurement what would be the value of $p(0) \; and \; p(1)$. 3+3+2=8

5. (a). What do you understand by Quantum Superposition?
   Consider the state $|\varphi> = \; [a(|000> + |100> + |011> + |111>) + b(|010> - |110> + |001> - |101>)]$

If one measures the first 2-qubits and get the result (i) 00 and (ii) 11 what will happen to the superposition state $|\varphi>$.

5.(b). Consider the following quantum circuit, give the matrix representation of it? Give the inverse of that matrix (4+4)=8



6. a) Define Quantum Fourier Transformation (QFT).

b) Find out the Quantum Fourier Transform matrix of the 2-qubit state

and hence prove that the quantum Fourier Transform Operator (QFT) is unitary.

c) Draw the quantum circuit of such QFT using necessary Quantum Gates and hence draw the 3-qubit QFT circuit. 1+(2+2)+(2+1)=8

7. a).Write down the time complexity of Shor factoring algorithm? Discuss the impact of Shor algorithm on RSA cryptosystem.
b). Apply Shor algorithm to factor 39 into two prime numbers and calculate the complexity of it. 2+6=8

8. a)Write down the time complexity of Grover's search algorithm. Compare it with classical linear search.
b)What is Quantum Oracle? Why it is used in Grover's search algorithm.
c)Consider a search space of size N=8, run Grover's algorithm to search the element x_0 which is represented by the bit string 011.
Hence calculate the complexity of such searching.
(1+1+1+1)+3+1=8

9. What is quantum teleportation? How many different channels are required in Quantum Teleportation? Do you think teleportation is faster than light? Explain.
Suppose, Alice wants to teleport her state $|\psi> = a_0|0> + a_1|1>$ to Bob. Write down necessary steps how Alice will teleport it to Bob.
Draw the quantum circuit for such teleportation. (2+1)+(3+1)=8

10. (a). " *Quantum cryptosystem has unconditional security*"- Explain
What are the various steps for secured quantum key distribution (QKD) between Alice and Bob?
(b). How the qubit is generated using polarization states of photon?
Why a classical channel is required for secured QKD distribution system?
(c)Consider the following table with numbers and symbols having their usual significance. Find out the raw key, shifted key and hence secured secret quantum key

(d). How the presence of Eve could be detected in QKD system?

Alice's random bit	0	1	1	0	1	0	0	1
Alice's random sending basis	+	+	×	+	×	×	×	+
Photon polarization Alice sends	↑	→	↘	↑	↘	↗	↗	→
Bob's random measuring basis	+	×	×	×	+	×	+	+
Photon polarization Bob measures	↑	↗	↘	↗	→	↗	→	→

1+2+2+2+1=8

M.Sc. Semester IV Examination, 2025
Computer Science
Department of Computer and System Sciences, Visva-Bharati
MCSO-09: Data Mining

Full Marks: 40 Time: 3 hours

Answer Question no. 1 and any three Questions from the rest

1. Answer any five questions 2×5=10

   (a) How can dissimilarities between two asymmetric binary variables be measured?

   (b) What are the components and significance of a five-number summary in statistical data analysis?

   (c) Why is a Q–Q plot important in statistical analysis?

   (d) Briefly discuss the procedure for constructing parallel coordinates plots to represent high-dimensional data.

   (e) How can missing data be handled?

   (f) Explain data discrepancy with an example.

2. (a) How can the quality of data be measured? Provide an example.

   (b) Given the following list of ages of 12 individuals: [22, 25, 27, 29, 31, 34, 35, 36, 38, 42, 45, 48], perform data binning to preprocess the numerical values. First, apply equal-width binning to divide the data into three bins. For each bin, identify the range and list the data points that fall within it. Then, apply two bin labeling techniques: binning by mean and binning by boundary and show the results.

   (c) Why is it necessary to perform data reduction? Discuss various strategies used for data reduction. 2+(2+3)+3=10

3. A hospital chain wants to build a data warehouse to support decision-making related to patient care, resource allocation, and operational efficiency. The data sources include patient records, lab reports, billing systems, and appointment schedules from multiple branches.

   Describe the key steps involved in designing an effective data warehouse for this healthcare system. Additionally, explain the differences between a star schema and a snowflake schema in the context of this case study. Under what conditions would you recommend using each schema? Justify your answer with relevant examples. 6+2+2=10

4. You are given a dataset of 10 transaction records from a retail pharmacy, where each transaction lists the items purchased together. Assume minimum support threshold is 30% and minimum confidence threshold is 70%.

Transaction ID	Items Purchased
T_1	Paracetamol, Cough Syrup, Vitamin C
T_2	Paracetamol, Vitamin C
T_3	Cough Syrup, Antacid
T_4	Paracetamol, Antacid, Vitamin C
T_5	Paracetamol, Cough Syrup
T_6	Cough Syrup, Vitamin C
T_7	Paracetamol, Vitamin C, Multivitamin
T_8	Paracetamol, Antacid, Multivitamin
T_9	Cough Syrup, Vitamin C
T_{10}	Paracetamol, Cough Syrup, Antacid

(a) Construct the FP-tree for the given transactions.

(b) Identify all frequent itemsets that meet the minimum support.

(c) Generate strong association rules. 5+3+2=10

5. You are given the following dataset of 2D points:

Point ID	Coordinates (x, y)
P_1	(1, 2)
P_2	(2, 2)
P_3	(2, 3)
P_4	(8, 7)
P_5	(8, 8)
P_6	(25, 80)
P_7	(24, 79)
P_8	(25, 81)
P_9	(26, 80)
P_{10}	(70, 50)

(a) Use DBSCAN Algorithm to identify the final clusters and identify the points considered as noise. Assume the Epsilon (ε) = 2 and Minimum Points (MinPts) = 3.

(b) Why is DBSCAN considered a non-deterministic clustering algorithm?

(c) How to estimate the value of MinPts parameter in DBSCAN. 6+2+2=10

6. (a) Describe the basic working mechanism of the k-NN algorithm for classification.

(b) Discuss how the selection of the parameter k influences the performance of the k-NN algorithm.

(c) Why is k-NN categorized as a *lazy learner*?

(d) How does the choice of distance metric affect the classification outcome? 4+2+2+2=10