Cochin University of Science and Technology

Department of Computer Science

Fourth Semester M.Sc. (Five-Year Integrated) in Computer Science (Artificial Intelligence & Data Science)

First Series Examination - February 2025

23-813-0403: Digital Signal Processing

Duration : 2 Hrs

Maximum Marks : 20

Answer all questions.

1. Determine whether the following system is shift invariant or not.

   $y(n) = x^2(n) + 3n$

   [2 marks][CO1, DL-2, BTL-2]

2. Determine whether the following system is linear or not.

   $y(n) = \frac{sin(x(n))}{x(n)}$

   [2 marks][CO1, DL-2, BTL-2]

3. Compute the 2D linear convolution between the following two signals:

   $x(m,n) = \begin{bmatrix} 7 & 8 & 8 \\ 1 & 0 & 1 \\ 8 & 8 & 9 \end{bmatrix}$ and $h(m,n) = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$

   [4 marks][CO1, DL-2, BTL-3]

4. A 4×4 image is shown below:

   $$\begin{bmatrix} 2 & 8 & 3 & 1 \\ 3 & 2 & 7 & 8 \\ 2 & 4 & 8 & 9 \\ 6 & 7 & 7 & 8 \end{bmatrix}$$

   Apply a 3×3 average filter to the above input image. Assume replicate padding.

   [4 marks][CO4, DL-2, BTL-3]

5. Compute the 2D DFT of the following 2D signal:

   $$\begin{bmatrix} 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \end{bmatrix}$$

   [4 marks][CO3, DL-2, BTL-3]

6. A 4×4 image is given by:

   $$\begin{bmatrix} 7 & 7 & 4 & 5 \\ 2 & 6 & 6 & 8 \\ 5 & 4 & 3 & 1 \\ 9 & 8 & 8 & 5 \end{bmatrix}$$

   Apply a 3×3 median filter on the above input image. Assume replicate padding.

   [4 marks][CO4, DL-2, BTL-3]

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

Programme: M.Sc. (Five Year Integrated) in Computer Science (Artificial Intelligence & Data Science)

Course Code & Title: 21-805-0405 Optimization Techniques

Name of Examination: Series I I			
Batch: 2023-28	Duration: 2 Hours	Max. Marks: 20	Semester: IV
		Date: 21.03.2025	Time: 09:00 AM – 11 AM

Answer all questions

1. Maximize
   Z=100x1+150x2
   Subject to
   8000x1+4000x2≤40,000
   15x1+30x2 ≤200
   x1,x2>= 0 and integers. Solve using branch and bound method
   [Graphical solutions is x1=2.22, x2=5.56]

   [6 marks][CO3 DL-3, BTL-3]

2. Describe the selection process in a genetic algorithm.

   [5 marks][CO4, DL-1, BTL-2]

3. Explain the crossover operation and its role in genetic algorithms

   [5 marks][CO4, DL-3, BTL-3]

4. Suppose that there are five jobs, each of which has to be processed on two machines A and B in the order AB. Processing times are given in the following table: Find the optimal sequencing order

Job	Machine A	MachineB
1	6	3
2	2	73
3	10	8
4	4	9
5	11	5

[4 marks][[CO3, DL-3, BTL-4]

I Answer the following (1 Mark each*5 questions= 5 marks)

1. Which among the following is true representation of a burn down chart?
a) Effort estimate vs Time
b) Work remaining vs Time
c) Work remaining vs Effort estimate
d) Work completed vs Effort estimate
[CO6, DL-2, BTL-2]

2. Which among the following is not a valid Agile Ceremony?
a) Sprint Retro b) Sprint Redo c) Sprint planning d) Daily scrum meetings
[CO1, DL-1, BTL-1]

3. Which among the following is a unit to estimate individual tasks?
a) Nebulous units of time b) Velocity points c) Cookies d) Stone points
[CO1, DL-2, BTL-1]

4. According to agile principles, what is the primary measure of progress?
a) Reducing the development time b) Following better processes
c) Promoting sustainable teams d) Working Software
[CO6, DL-1, BTL-2]

5. What does a steep slope of a burndown chart represent?
a) High velocity b) Low velocity c) High delay d) Low delay
[CO1, DL-2, BTL-5]

II Answer the following (Total of 15 marks)

6. Explain role of a product owner in an agile project? (3 marks). [CO6, DL-1, BTL-4]

7. Distinguish between Epic, User story and Task in a software project. (3 marks) [CO4, DL-1, BTL-2]

8. Note down 5 key aspects of an elevator pitch of a software product. (3 marks) [CO6, DL-1, BTL-3]

9. Note down 10 principles of Agile Software project management (6 marks) [CO1, DL-1, BTL-2]

****

Cochin University of Science and Technology

Department of Computer Science

Fourth Semester Five Year Integrated M.Sc. in Computer Science (Artificial Intelligence & Data Science)

Second Series Examination - March 2025

23-813-0403: Digital Signal Processing

Duration : 2 Hrs

Maximum Marks : 20

Answer all questions.

1. A 4×4 image is shown below:

$$\begin{bmatrix} 3 & 2 & 1 & 3 \\ 1 & 4 & 9 & 6 \\ 9 & 8 & 8 & 8 \\ 4 & 4 & 7 & 9 \end{bmatrix}$$

Apply a 3×3 alpha trimmed mean filter with $\alpha = 6$ to the above input image. Assume replicate padding.

[4 marks][CO4, DL-2, BTL-3]

2. A 4×4 image is given by:

$$\begin{bmatrix} 12 & 6 & 2 & 1 \\ 18 & 7 & 8 & 15 \\ 5 & 17 & 14 & 12 \\ 7 & 14 & 11 & 10 \end{bmatrix}$$

Filter the above input image using a 3×3 mid-point filter. Assume replicate padding.

[4 marks][CO4, DL-2, BTL-3]

3. Illustrate how Laplacian filter can be applied in the frequency domain.

[4 marks][CO3, DL-1, BTL-1]

4. Discuss about any two frequency domain high pass filters with the help of neat sketches.

[4 marks][CO3, DL-1, BTL-1]

5. Write short notes on the following:
   (a) Homomorphic filtering.
   (b) Image degradation model.

[4 marks][CO3, DL-1, BTL-1]

Cochin University of Science And Technology

Department of Computer Science

Fourth Semester M.Sc. (Five-Year Integrated) in Computer Science (Artificial Intelligence & Data Science)

Second Series Examination – March 2025

23-813-0402: Numerical Methods

Duration: 2 Hours | Maximum Marks: 20

Answer all questions.

1. a. What is numerical differentiation? Give FDF and BDF Formula for Estimating the first derivative. [CO1, DL-1, BTL-1] 3 marks

   b. Given $f(x)=x^2+2x+3$, approximate $f'(3)$ using the Backward Divided Difference method with step size $h=0.1$. Also estimate the True error and trends in the true error as a function of step size. [CO1, DL-2, BTL-2] 3 marks

2. a. What is the **Multiple Trapezoidal Rule** and how does it improve accuracy compared to the Simple Trapezoidal Rule? [CO1, DL-2, BTL-3] 2 marks

   b. Apply the **Multiple Trapezoidal Rule** to approximate the following integral with $n=10$.

   $$\int_0^5 (x^3 + 4)dx$$

   [CO2, DL-2, BTL-2] 3 marks

3. a. Derive the formula for second derivative of a continuous function using Taylor series. [CO3, DL-2, BTL-3] 3 marks

   b. Find the **second derivative** of $f(x)=x^3-4x^2+5x-2$ and approximate $f''(2)$. Also estimate the True value of $f''(2)$ and True error for $f''(2)$.

   [CO3, DL-2, BTL-3] 3 marks

4. Use Boole's Rule to approximate the integral:

$$\int_0^4 (x^2 + 1)dx$$

[CO2, DL-2, BTL-2] 3 marks

Cochin University of Science and Technology

Department of Computer Science

Fourth Semester M.Sc. (Five-Year Integrated) in Computer Science (Artificial Intelligence & Data Science)

First Series Examination - February 2025

23-813-0403: Digital Signal Processing

Duration : 2 Hrs | Maximum Marks : 20

Answer all questions.

1. Determine whether the following system is shift invariant or not. [2 marks][CO1, DL-2, BTL-2]

$$y(n) = x^2(n) + 3n$$

2. Determine whether the following system is linear or not. [2 marks][CO1, DL-2, BTL-2]

$$y(n) = \frac{sin(x(n))}{x(n)}$$

3. Compute the 2D linear convolution between the following two signals: [4 marks][CO1, DL-2, BTL-3]

$$x(m,n) = \begin{bmatrix} 7 & 8 & 8 \\ 1 & 0 & 1 \\ 8 & 8 & 9 \end{bmatrix} \text{ and } h(m,n) = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

4. A 4×4 image is shown below:

$$\begin{bmatrix} 2 & 8 & 3 & 1 \\ 3 & 2 & 7 & 8 \\ 2 & 4 & 8 & 9 \\ 6 & 7 & 7 & 8 \end{bmatrix}$$

Apply a 3×3 average filter to the above input image. Assume replicate padding. [4 marks][CO4, DL-2, BTL-3]

5. Compute the 2D DFT of the following 2D signal: [4 marks][CO3, DL-2, BTL-3]

$$\begin{bmatrix} 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \end{bmatrix}$$

6. A 4×4 image is given by:

$$\begin{bmatrix} 7 & 7 & 4 & 5 \\ 2 & 6 & 6 & 8 \\ 5 & 4 & 3 & 1 \\ 9 & 8 & 8 & 5 \end{bmatrix}$$

Apply a 3×3 median filter on the above input image. Assume replicate padding. [4 marks][CO4, DL-2, BTL-3]

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

Programme: Five Year Integrated M.Sc. in Computer Science (Artificial Intelligence and Data Science)

Course Code & Title: 21-805-0404: Agile Software Engineering

Name of Examination: Series I		Max. Marks: 20	Semester: IV
Batch:	Duration: 2 Hours	Date: 13.2.2025	Time: 9AM – 11AM

I Answer the following (1 Mark each*5 questions= 5 marks)

1. Which among the following is TRUE?
a) The project manager verifies and closes a bug reported by QA and fixed by Developer
b) A bug cannot be reopened once it is fixed by developer; instead a new bug is filed.
c) Fixing bugs are always lower priority than performing development tasks in a sprint.
d) Each bug is closed only by the person who reported the bug.

[CO1, DL-2, BTL-2]

2. Which among the following is not part of Agile Manifesto?
a) Individuals and interactions over processes and tools
b) Working Software over comprehensive documentation
c) Customer Separation over contract negotiation
d) Responding to Change over following a plan

[CO6, DL-1, BTL-1]

3. What is a weak entity in an ER Diagram?
a) An entity type having only derived attributes b) An entity with composite attributes
c) An entity type which does not have a primary key d) An entity type having a foreign key

[CO2, DL-1, BTL-2]

4. In a software development team, the person who represents the client and makes design decisions is called
a) Project Manager b) Product Owner c) Scrum Master d) Business Analyst

[CO4, DL-1, BTL-1]

5. Which among the following is not a valid debugging technique?
a) Cause elimination b) Backtracking c) Program slicing d) Equivalence Partitioning

[CO5, DL-1, BTL-1]

II Answer the following (Total of 15 marks)

6. What are the difference types of maintenance done on software? Give an example for each. (3 marks) [CO1, DL-1, BTL-4]

7. Draw the software bug life cycle. (3 marks) [CO5, DL-1, BTL-1]

8. A mobile app is used to book a nearby available taxi car. Current location and destination is entered and nearest taxi car, operated by the driver using the same mobile app, will arrive. Once ride is complete, payment is done using credit card.

(i) Draw an ER diagram for the above application

(ii) Define the user stories in this project

(iii) Draw the software architecture for the mobile application.

(9 marks) [CO6, DL-2, BTL-3]

****

Cochin University of Science And Technology

Department of Computer Science

Fourth Semester IMSC Computer Science with specialization in Data Science and Artificial Intelligence

End Semester Examination – April 2025

23-813-0402: Numerical Methods

Duration: 3 Hours | Maximum Marks: 50

Answer all questions.

1. (a) How do the Numerical methods differ from Analytical methods? Explain with examples.

[4 marks][CO1, DL-1, BTL-1]

(b) Define error. What are different types of errors? Explain with proper examples.

[6 marks][CO1, DL-2, BTL-2]

OR

2. (a) What do you mean by error propagation? How we can mitigate it?

[4 marks][CO1, DL-2, BTL-3]

(b) What are significant digits? Explain the rules to identify the significant digits. Find the number of significant digits from the following numbers.

a) 67

b) 0.00634

c) 0.032

d) 59.004

e) 4700.0

[6 marks][CO1, DL-1, BTL-1]

3. (a) Find the root of $x^3-4x-9=0$ using false position method.

[5 marks][CO2, DL-2, BTL-3]

(b) Solve the following system of equations using Gauss Seidal Method.

$26x1 + 2x2 + 2x3 = 12.6$

$3x1 + 27x2 + x3 = -14.3$

$2x1 + 3x2 + 17x3 = 6.0$

[5 marks][CO1, DL-2, BTL-1]

OR

4. (a) Find a root of the equation $f(x) = x^3 - 5x + 1 = 0$ using the Newton-Raphson method. Perform **five iterations** and provide the approximate root.

[5 marks][CO2, DL-1, BTL-1]

(b) Solve the following system of equations using Relaxation Method.

$5x + 2y + z = -12$

$-x + 4y + 2z = 20$

$2x - 3y + 10z = 3$

[5 marks][CO1, DL-2, BTL-3]

5. (a) What are difference operators? Differentiate between leading forward differences and leading backward differences with the help of proper difference tables.

[5 marks][CO2, DL-2, BTL-1]

(b) Construct a forward difference table for the following data

x	0	10	20	30
y	0	0.174	0.347	0.518

[5 marks][CO1, DL-2, BTL-3]

OR

6. (a) $F(x) = x^2 + ax + b$. Calculate $\nabla^r f(x)$. [4 marks][CO2, DL-1, BTL-2]

(b) Use the appropriate interpolation technique and find the value of y at x = 15 for the following data. [6 marks][CO2, DL-1, BTL-3]

x	0	10	20	30	40
y	7	18	32	48	85

7. (a) Given $f(x)=2x^2+3x+3$, approximate $f'(2)$ using the Backward Divided Difference method with step size h=0.1. Also estimate the True error and trends in the true error as a function of step size.

[5 marks][CO2, DL-2, BTL-2]

(b) Evaluate the integral:

$$I = \int_1^7 \frac{1}{x}\,dx$$

Using Weddle's Rule. [5 marks][CO2, DL-3, BTL-3]

OR

8. (a) The velocity of a rocket is given by

$v(t) = 2000\ln[14*10^4/(14*10^4 - 2100t)]-9.8t$, $0<t<30$.

Use central difference approximation of the first derivative of v(t) to calculate the acceleration at t=16. Use step size of h=2.

Also find the true error

[5 marks][CO3 DL-1, BTL-1]

(b) Approximate the derivative of the function $f(x) = e^{-x}\sin(x)$ at the point x = 1.0 using central divided-difference formula and Richardson extrapolation starting with h = 0.5 and h=0.25.

[5 marks][CO2, DL-3, BTL-4]

9. (a) Find y(0.2) for $y'=(x-y)/2$, y(0) = 1, with step length 0.1 using Euler method.

[5 marks][CO2, DL-2, BTL-3]

(b) Find y(0.2) for $y'=x^2y-1$, y(0) = 1, with step length 0.1 using Taylor Series method

[5 marks][CO2, DL-2, BTL-2]

OR

10. (a) Find y(0.5) for $y'=-2x-y$, y(0) = -1, with step length 0.1 using Modified Euler method

[5 marks][CO3, DL-2, BTL-2]

(b) Use the second-order Runge-Kutta method to compute y(0.2) for:

$$\frac{dy}{dx} = x^2 + y^2$$

With y(0) = 1, and step size h = 0.1.

[5 marks][CO3, DL-3, BTL-3]

Cochin University of Science and Technology

Department of Computer Science

Fourth Semester M. Sc. (Five year Integrated) in Computer Science
(Artificial Intelligence and Data Science)

21-805-0404: Agile Software Engineering

End Semester Examination **April 2025** **Total: 50 marks** **Time: 3 hours**

(Answer either Part A or Part B of each question. Each Part carries 10 marks)

Module I

I A 1) Draw the life cycle of a bug? If a bug is reopened and closed again, what type of testing would you recommend?
(10 marks) [CO3, DL-1, BTL-1]

OR

I B 1) A home automation system has a mobile app which communicates to a backend application at home, through which user can control lights and fans an apartment. List the Epics, User Stories and Tasks in developing the system.
(10 marks) [CO2, DL-3, BTL-5]

Module II

II A 1) Describe Agile manifesto. Explain reasons why software industry moved into agile methodology.
2) Explain these terms: a) Mean Time To Failure b) Mean Time Between Failure
(5+5 marks) [CO5, DL-2, BTL-2]

OR

II B 1) What is Software Reliability? What is the 90%-10% rule of software reliability.
2) Provide Entity Relationship diagram for the application in the question I B 1.
(5+5 marks) [CO1, DL-2, BTL-3]

Module III

III A 1) Explain the activities in the following sprint ceremonies in detail.
a) Daily scrum b) Sprint Retro c) Sprint demo
(10 marks) [CO4, DL-1, BTL-1]

OR

III B 1) What is velocity of an agile project. How does burn down chart represent velocity?
2) Distinguish between roles of a project manager and a product owner.
(5+5 marks) [CO6, DL-1, BTL-1]

Module IV

IV A 1) What are the claimed benefits of CMMI? What are its maturity levels?
(10 marks) [CO5, DL-2, BTL-2]

OR

IV B 1) Explain MoSCoW model of software development. How are tasks prioritized in this model?
(10 marks) [CO5, DL-2, BTL-2]

Module V

V A 1) An HR portal in a firm contains information such as: Employee Name, Designation, Department, Manager Name. HR Portal can be used to apply leave by employees to their reporting employees for approval. The leave information can be exported from this portal for salary calculation. Create a list of 3 User Stories, estimate effort for each of its subtasks, make technology assumptions and create sprint plan assuming a couple of full stack developers are available to develop this application.
(10 marks) [CO7, DL-3, BTL-3]

OR

V B 1) An apartment society has a management software containing information such as: name of flat owner, profession of owner, address, type of flat, phone number of each member. Maintenance fee is applicable based on each type of flat and it can be paid by owner of each flat through the application. Create a list of 3 User Stories, estimate effort for each of its subtasks, make technology assumptions and create sprint plan assuming a couple of full stack developers are available to develop this application.
(10 marks) [CO7, DL-2, BTL-3]

****

Library

Cochin University of Science and Technology

Department of Computer Science

M.Sc. (Five-Year Integrated) in Computer Science (Artificial Intelligence & Data Science)

End Semester Examination - April 2025

21-805-0405: Optimization Techniques

Duration : 3 Hrs

Maximum Marks : 50

Answer all questions. From each question fully answer either (a) or (b).

1. (a) Minimize $f = -x1 - 2x2 - x3$

st

$2x1+x2-x3 \leq 2$

$2x1 - x2 + 5x3 \leq 6$

$4x1 + x2 + x3 \leq 6 \qquad xi \geq 0$

((10 marks) [CO1, DL-3, BTL-3])

OR (b and c)

(b) A furniture company produces two types of chairs: Standard Chairs and Luxury Chairs. Each Standard Chair requires 2 hours of labor and 3 units of wood. Each Luxury Chair requires 5 hours of labor and 4 units of wood.The company has a maximum of 80 labor hours available per week. The company has a maximum of 100 units of wood available per week. The profit per Standard Chair is Rs. 30, and the profit per Luxury Chair is Rs. 50. The company wants to determine the optimal number of each type of chair to produce in order to maximize profit. . **((5 marks) [CO1, DL-3, BTL-3])**

(c) A recycling plant sorts aluminum cans and plastic bottles. Processing one aluminum can yields a profit of 2Rs while processing one plastic bottle yields a profit of 4Rs. The plant has a maximum daily capacity of processing 200 items (cans and bottles combined). Additionally, due to limitations in the sorting machine, they can only process a maximum of 120 aluminum cans per day. Can you graphically determine the number of aluminum cans (x1) and plastic bottles (x2) the plant should process each day to maximize their profit, considering the limitations and profit per item? **((5 marks) [CO1, DL-3, BTL-3])**

2. (a) A company has three warehouses (W1, W2, and W3) that supply a product to four retail stores (S1, S2, S3, and S4). The supply available at each warehouse and the demand at each store are given in the table below. The company wants to determine the optimal transportation plan to minimize total transportation costs.(Table 1) **((10 marks) [CO2, DL-2, BTL-3])**

OR

(b) A manufacturing company needs to process 5 jobs on two machines. The processing times (in hours) for each job on each machine are given below. determine the optimal sequence of jobs that minimizes the total processing time. Also, calculate the total time required to complete all jobs.
((10 marks) [CO2, DL-2, BTL-3])

Warehouse → Store	S1	S2	S3	S4	Total
W1	4	3	2	6	50
W2	5	4	3	7	60
W3	8	6	4	5	40
	30	40	50	30	

Table 1: 2 (a)Transportation Costs per Unit from Warehouses to Stores

Job	Machine 1 (M_1)	Machine 2 (M_2)
J_1	5	3
J_2	7	6
J_3	4	2
J_4	9	7
J_5	6	5
J_6	8	4

Table 2: 2(b)Processing Times for Jobs on Two Machines

3. (a) A company sells 10,000 units of a product annually. The cost to place an order is Rs50, and the holding cost per unit per year is Rs 2. Using the Economic Order Quantity (EOQ) model, determine the optimal order quantity that minimizes total inventory costs. What is the total annual cost associated with ordering and holding inventory using the EOQ approach? Determine the number of orders in an year. Also determine how often should an order be placed. **((10 marks) [CO3, DL-2, BTL-3])**

OR

(b) Solve the following LP problem using the branch and bound method
Maximize $f = 3x1 + 4x2st$
$7x1 + 11x2 \leq 88$
$3x1 - x2 \leq 12$ $xi \geq 0$ and integers **((10 marks) [CO2, DL-2, BTL-3])**

4. (a) Can you explain the role of the fitness function in Genetic Algorithms and how it guides the evolutionary process? How does the crossover operator in Genetic Algorithms contribute to the diversity of the solution pool? **((10 marks) [CO3, DL-1, BTL-2])**

OR

(b) Explain the core concept behind Genetic Algorithms and how they mimic biological evolution for problem-solving. Describe the different stages involved in a typical Genetic Algorithm cycle **((10 marks) [CO3, DL-1, BTL-2])**

5. (a) How does Particle Swarm Optimization mimic the social behavior observed in nature, such as fish schooling or bird flocking? Can you describe the mathematical model that underpins Particle Swarm Optimization, including how particles update their velocity and position? [CO4, DL-2, BTL-2]

OR

(b) Describe the optimization involved in PSO algorithm How does PSO ensure that particles converge towards the global optimum rather than getting trapped in local optima? [CO4, DL-2, BTL-2]

Library copy

Cochin University of Science and Technology

Department of Computer Science

Five Year Integrated M.Sc. in Computer Science (Artificial Intelligence & Data Science)

End Semester Examination: April 2025

23-813-0403: Digital Signal Processing

Duration : 3 Hrs | Maximum Marks : 50

Answer all questions. From each question fully answer either (a) or (b)

1. (a) (i) Determine whether the system described by the following input-output relation is linear shift invariant or not.
$y(n) = nx(n) + x(n+2) + y(n-2)$ [5 marks][CO1, DL-2, BTL-3]

(ii) Define Markov process. Explain its applications in signal processing. [5 marks][CO1, DL-1, BTL-2]

OR

(b) (i) Determine whether the 2D signal $x(t) = cos(4t) + 2sin(8t)$ is periodic or not. If periodic, determine the fundamental period. [5 marks][CO1, DL-2, BTL-3]

(ii) Write short notes on:
- Exponential sequence.
- Comb function.

[5 marks][CO1, DL-1, BTL-1]

2. (a) (i) Perform linear convolution between the signals
$x(m,n) = \begin{bmatrix} 7 & 3 & 1 \\ 7 & 5 & 9 \\ 3 & 7 & 9 \end{bmatrix}$ and $h(m,n) = \begin{bmatrix} 2 & 1 & 6 \\ 3 & 3 & 9 \end{bmatrix}$ [5 marks][CO3, DL-2, BTL-3]

(ii) With the help of an example prove the convolution property of a 2D DFT. [5 marks][CO3, DL-2, BTL-3]

OR

(b) (i) An image matrix is given by
$f(m,n) = \begin{bmatrix} 3 & 1 & 0 & 1 \\ 3 & 2 & 0 & 0 \\ 2 & 3 & 1 & 0 \\ 1 & 2 & 0 & 3 \end{bmatrix}$. Compute its 2D DFT. [7 marks][CO3, DL-2, BTL-4]

(ii) Explain the concept of frequency response and Eigenfunction of a shift invariant system. [3 marks][CO3, DL-1, BTL-1]

3. (a) (i) Briefly explain any two band reject filters with the help of neat sketches. Also comment on its applications. [6 marks][CO4, DL-1, BTL-2]

(ii) Highlight the significance of Butterworth filters over other frequency domain filters. [4 marks][CO4, DL-1, BTL-2]

OR

(b) (i) Discuss the significance of high pass filtering in frequency domain. Describe any two high pass filters with the help of neat diagrams. [6 marks][CO4, DL-1, BTL-2]

(ii) Illustrate the working principle of homomorphic filtering. [4 marks][CO4, DL-1, BTL-2]

4. (a) (i) Filter the following image using a 3×3 mid-point filter mask.

$$f(m,n) = \begin{bmatrix} 6 & 12 & 13 & 12 \\ 5 & 11 & 15 & 11 \\ 6 & 10 & 15 & 12 \\ 8 & 9 & 12 & 10 \end{bmatrix}$$

. Assume replicate padding. [5 marks][CO4, DL-2, BTL-3]

(ii) Apply a 3×3 alpha trimmed mean filter with $\alpha = 6$ on the following image:

$$f(m,n) = \begin{bmatrix} 6 & 11 & 9 & 14 \\ 7 & 11 & 10 & 12 \\ 11 & 10 & 10 & 10 \\ 15 & 10 & 15 & 11 \end{bmatrix}$$

. Assume replicate padding.

OR

(b) (i) Apply a 3×3 median filter on the following image: [5 marks][CO4, DL-2, BTL-3]

$$f(m,n) = \begin{bmatrix} 11 & 13 & 13 & 15 \\ 12 & 15 & 14 & 13 \\ 10 & 14 & 12 & 11 \\ 14 & 12 & 12 & 10 \end{bmatrix}$$

. Assume replicate padding.

(ii) Write short notes on:

- Adaptive filters.
- Switching median filters. [6 marks][CO4, DL-2, BTL-3]

5. (a) (i) Briefly explain the significance of Wiener filter over other restoration filters. [4 marks][CO4, DL-1, BTL-1]

(ii) Illustrate how the magnitude and phase spectrum can be extracted using Discrete Fourier Transform. [5 marks][CO4, DL-1, BTL-1]

OR [5 marks][CO4, DL-1, BTL-2]

(b) (i) Illustrate the working principle of Direct inverse filtering.

[5 marks][CO4, DL-1, BTL-1]

(ii) Discuss about any two notch pass filters with the help of neat sketches. Comment on its applications.

[5 marks][CO4, DL-1, BTL-2]

OR

(b) i) Describe the giant component in the Erdős-Rényi model $G(n, p)$ and explain how t transition from small components to a giant component occurs as the edge probability 'p' varied.

[10 marks] [CO2, DL-2, BTL-3]

3. (a) i) A customer loyalty program has three states: 'New' (N), 'Regular' (R), and 'Loyal' (L). The following transition probabilities are observed:
N to N: 60%, N to R: 30%, N to L: 10%
R to N: 20%, R to R: 50%, R to L: 30%
L to N: 5%, L to R: 15%, L to L: 80%
Given an initial customer distribution of 70% 'New', 20% 'Regular', and 10% 'Loyal' Calculate the customer distribution after two steps.

ii) Determine the stationary distribution of this Markov chain and explain its practical implications for the retail store's loyalty program and marketing strategies.

[10 marks] [CO2, DL-3, BTL-3]

OR

(b) i) Describe the Gibbs sampling algorithm in detail. Explain how the algorithm constructs a Markov chain that converges to the target distribution.

[5marks] [CO2, DL-2, BTL-3]

ii) Describe how the Metropolis-Hastings algorithm uses a Markov chain to generate samples from a complex, potentially unknown probability distribution.

[5marks] [CO2, DL-2, BTL-2]

4. (a) i) Describe the Perceptron algorithm's learning process. Explain how it iteratively updates the weight vector based on misclassified samples.

[5 marks] [CO3, DL-1, BTL-2]

ii) Provide examples of set systems and discuss how to determine their VC dimension. Explain the concept of the shatter function in relation to VC dimension.

[5 marks] [CO3, DL-1, BTL-1]

OR

(b) i) Describe the bootstrap aggregating technique and explain how it works.

[4 marks] [CO3, DL-3, BTL-3]

ii) Define ensemble learning and explain why it often leads to better predictive performance than single models.

[6 marks] [CO3, DL-2, BTL-2]

5. (a) i) Describe the essential steps involved in finding similar documents. Explain the purpose and key techniques used in each step.

[3 marks] [CO4, DL-3, BTL-3]

ii) Given four web pages as sets of shingles:

Page A: {a, b, c, d}
Page B: {b, d, e, f}
Page C: {a, c, g}
Page D: {a, b, d, e}
Create a min hash signature matrix using hash functions:
$h1(x) = (x + 1) \bmod 7$
$h2(x) = (3x + 2) \bmod 7$
$h3(x) = (5x + 3) \bmod 7$
Estimate Jaccard similarity between A-B, A-C, and A-D using the min hash matrix.
Compare with actual Jaccard similarities.

[7 marks] [CO4, DL-2, BTL-2]

OR

(b) i) A small online bookstore tracks customer purchases. The store's transaction database contains the following purchase records:

T1: {Books A, B, C}
T2: {Books A, C}
T3: {Books A, D}
T4: {Books B, E, F}
T5: {Books B, C, D}
T6: {Books A, B, D}
T7: {Books C, E}
T8: {Books A, B, C, D}
Using the Apriori algorithm, with a minimum support of 37.5% (3 out of 8 transactions) and a minimum confidence of 60%, find all frequent item sets.

[6 marks] [CO4, DL-1, BTL-3]

ii) Based on the frequent item sets found, generate association rules that meet the minimum confidence threshold.

[4 marks] [CO4, DL-2, BTL-2]

Cochin University of Science And Technology

Department of Computer Science

IV Semester Five Year Integrated M.Sc in Computer Science (Artificial Intelligence & Data Science)

Makeup Examination for the End Semester Examination – April 2025

23-805-0401: Foundation of Data Science

Duration: 3 Hours | Maximum Marks: 50

Answer all questions. From each question fully answer either (a) or (b)

1. (a) Find the Singular Value Decomposition of A, $U\sum V^T$, where $A = \begin{bmatrix} 4 & 0 \\ 3 & -5 \end{bmatrix}$

[10 marks] [CO1, DL-1, BTL-1]

OR

(b) Explain briefly about Multivariant Gaussian Distribution.

[10 marks] [CO1, DL-1, BTL-2]

2. (a) i) Explain the emergences of the Giant component in Erdos- Renyi graphs.

[5 marks] [CO2, DL-1, BTL-2]

ii) Explain preferential attachment model and power law distribution.

[5 marks] [CO2, DL-1, BTL-2]

OR

(b) Explain small world model. Mention the properties of small world graph.

[10 marks] [CO2, DL-1, BTL-2]

3. (a) Explain the Metropolis-Hasting method to design a Markov chain.

[10 marks] [CO2, DL-3, BTL-3]

OR

(b)Explain the Gibbs sampling technique.

[10 marks] [CO2, DL-2, BTL-2]

4. (a) i) Differentiate between linear separator and Nonlinear separator.

[5 marks] [CO3, DL-1, BTL-2]

ii)Differentiate between weak learners and strong learners of Machine Learning.

[5 marks] [CO3, DL-1, BTL-1]

OR

(b) i) Illustrate the concept of Perceptron learning model

[5 marks] [CO3, DL-3, BTL-3]

ii) Write a short note on Boosting in Machine Learning.

[5 marks] [CO3, DL-2, BTL-2]

5. (a) i) Illustrate the Apriori Algorithm for frequent item search with suitable example.

[6 marks] [CO4, DL-3, BTL-3]

ii)Explain different methods for sampling from massive data streams.

[4 marks] [CO4, DL-2, BTL-2]

OR

(b) Illustrate the working of LSH algorithm for ANN search with suitable example.

[10 marks] [CO4, DL-1, BTL-3]

Cochin University of Science and Technology

Department of Computer Science

Five-Year Integrated M.Sc.in Computer Science (Artificial Intelligence & Data Science)

End Semester Examination (Make-up): May 2025

23-813-0403: Digital Signal Processing

Duration : 3 Hrs | Maximum Marks : 50

Answer all questions. From each question fully answer either (a) or (b)

1. (a) (i) Define LSI systems. Derive the convolution operation for an LSI system.
[5 marks][CO1, DL-2, BTL-3]

(ii) Define exponential function. Highlight the significance of exponential functions in signal processing.
[5 marks][CO1, DL-1, BTL-2]

OR

(b) (i) Define comb function. Describe its importance in sampling process.
[5 marks][CO1, DL-2, BTL-3]

(ii) Write short notes on:
- Static and Dynamic Systems.
- Stable Systems.

[5 marks][CO1, DL-1, BTL-1]

2. (a) (i) Perform linear convolution between the signals $x(m,n) = \begin{bmatrix} 11 & 12 & 10 \\ 16 & 10 & 12 \\ 11 & 10 & 12 \end{bmatrix}$ and $h(m,n) = \begin{bmatrix} 2 & 4 & 4 \\ 3 & 3 & 2 \end{bmatrix}$ [5 marks][CO3, DL-2, BTL-3]

(ii) An image matrix is given by $f(m,n) = \begin{bmatrix} 2 & 1 & 2 & 2 \\ 1 & 2 & 2 & 2 \\ 2 & 1 & 1 & 1 \\ 1 & 2 & 2 & 2 \end{bmatrix}$. Compute its 2D DFT. [5 marks][CO3, DL-2, BTL-3]

OR

(b) (i) Prove that convolution in the spatial domain is equal to multiplication in the frequency domain by taking

$x(m,n) = \begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix}$ and $h(m,n) = \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix}$ [7 marks][CO3, DL-2, BTL-4]

(ii) Define 2D DFT. Explain its significance in signal processing. [3 marks][CO3, DL-1, BTL-1]

3. (a) (i) Briefly explain any two band pass filters with the help of neat sketches. Also comment on its applications. [6 marks][CO4, DL-1, BTL-2]

(ii) Explain the significance of centering a frequency rectangle in frequency domain filtering. [4 marks][CO4, DL-1, BTL-2]

OR

(b) (i) Discuss the significance of low pass filtering in frequency domain. Describe any two low pass filters with the help of neat diagrams. [6 marks][CO4, DL-1, BTL-2]

(ii) What do you mean by ringing artifact in frequency domain filtering? How it can be resolved? [4 marks][CO4, DL-1, BTL-2]

4. (a) (i) Filter the following image using a 3×3 weighted average filter mask $\begin{bmatrix} 2 & 2 & 2 \\ 2 & 4 & 2 \\ 2 & 2 & 2 \end{bmatrix}$:

$$f(m,n) = \begin{bmatrix} 2 & 3 & 3 & 2 \\ 2 & 3 & 1 & 2 \\ 1 & 2 & 3 & 1 \\ 2 & 3 & 2 & 1 \end{bmatrix}$$

Assume replicate padding. [5 marks][CO4, DL-2, BTL-3]

(ii) Apply a 3×3 alpha trimmed mean filter with $\alpha = 4$ on the following image:

$$f(m,n) = \begin{bmatrix} 2 & 2 & 1 & 4 \\ 4 & 6 & 1 & 3 \\ 2 & 2 & 3 & 3 \\ 1 & 2 & 3 & 4 \end{bmatrix}.$$

Assume replicate padding.

OR

(b) (i) Apply a 3×3 median filter on the following image: [5 marks][CO4, DL-2, BTL-3]

$$f(m,n) = \begin{bmatrix} 8 & 7 & 8 & 9 \\ 6 & 7 & 7 & 1 \\ 4 & 5 & 6 & 7 \\ 9 & 9 & 6 & 7 \end{bmatrix}.$$

Assume replicate padding.

(ii) Write short notes on:

- Harmonic mean filter.
- Contra harmonic mean filter.

[6 marks][CO4, DL-2, BTL-3]

[4 marks][CO4, DL-1, BTL-1]

5. (a) (i) Briefly explain the working principle of Direct Inverse filter.

[5 marks][CO4, DL-1, BTL-1]

(ii) Discuss about any two notch pass filters with the help of neat sketches.

[5 marks][CO4, DL-1, BTL-2]

OR

(b) (i) Illustrate the working principle of Wiener filter.

[5 marks][CO4, DL-1, BTL-1]

(ii) Highlight the significance of frequency domain filters over spatial domain filters.

[5 marks][CO4, DL-1, BTL-2]

Cochin University of Science And Technology

Department of Computer Science

IV Semester Five Year Integrated M.Sc in Computer Science (Artificial Intelligence & Data Science)

End Semester Examination - April 2025
Regular and Supplementary

23-813-0401/23-805- 0401: Foundation of Data Science

Duration: 3 Hours | Maximum Marks: 50

Answer all questions. From each question fully answer either (a) or (b)

1. (a) i) Given a 2 D random variable $X \sim N(\mu, \sum)$ Where, $\mu = \begin{matrix}2\\0\end{matrix}$ $\Sigma = \begin{bmatrix}2 & 1\\1 & 3\end{bmatrix}$. Compute the probability density function at a given point $x = \begin{matrix}1\\1\end{matrix}$

ii) Describe the geometric effect of μ and $\sum$ on the distribution's shape.

iii) Explain the general use of a GMM for muti-modal data.

[10 marks] [CO1, DL-1, BTL-1]

OR

(b) i) Consider the matrix $D = \begin{bmatrix}1 & -2\\2 & 1\end{bmatrix}$. Determine the Singular Value Decomposition of matrix D.

[5marks] [CO1, DL-1, BTL-2]

ii) Explain how the singular values in $\sum$ and the corresponding columns of U and V relate to scaling and rotation effects.

[5 marks] [CO1, DL-1, BTL-2]

2. (a) i) Describe the Barabási-Albert model for generating scale-free networks. Explain the concept of "preferential attachment" and how it influences the degree distribution of the resulting network.

[5 marks] [CO2, DL-1, BTL-2]

ii) Discuss the key differences between the BA model and the Erdős-Rényi (ER) random graph model, particularly in terms of degree distribution and network structure.

[5marks] [CO2, DL-1, BTL-2]