*Candidates are required to give their answers in their own
words as far as practicable.
The figures in the margin indicate full marks.*

Digital Image Processing

[Theory]

Group - A

Answer *any two* of the following: 2×15=30

1. a) What is thresholding? What is the role of thresholding in image processing? List the different types of thresholding

    b) Explain the components of an image processing system, with the help of a suitable diagram   (2+3+2) + 8=15

2. Differentiate between Low-pass filter and High-pass filter with suitable example.

$8 + 7=15$

3. What do you mean by Image Restoration? Discuss the Minimum Mean-square Error approach of Restoration.

$7 + 8=15$

4. Explain the process of Dilation and Erosion, with the help of a suitable example. Prove that Erosion and Dilation are dual transformations.

$8 + 7=15$

GROUP B

Answer *any one* of the following:

$1×10=10$

5. (a) Define Sampling and Quantization.

   (b) What are the three types of discontinuity in a digital images?

$2+2+3+3=10$

6. (a) Describe histogram equalization. Obtain histogram equalization for the following image segment of size 5 X 5.

$$20\ 20\ 20\ 18\ 16$$
$$15\ 15\ 16\ 18\ 15$$
$$15\ 15\ 19\ 15\ 17$$
$$16\ 17\ 19\ 18\ 16$$
$$20\ 18\ 17\ 20\ 15 \qquad \text{(5 X 5) matrix}$$

10

[Practical]

Answer **any one** of the following: 1×20=20

7. Write a program (in MATLAB) to implement the Basic Gray Level Transformation.

8. Write a program (in MATLAB) to perform Histogram Equalization.

9. Write a program (in MATLAB) to implement Sharpening (Highpass) Frequency Domain Filters

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Introduction to Data Science

[Theory]

Group - A

Answer **any two** of the following: 2×15=30

1. What are the main components in Data Science? Write down the difference between business intelligence and data science?   8+7

2. Why data cleaning is necessary? What are the differences between overfitting and underfitting? Give example of overfitting and underfitting.   7+6+2

3. What does %% mean in R? What does && mean in R? Explain application of each instruction with suitable examples. What are the errors in hypothesis testing?

4+4+7

4. What is the difference between a Test Set and a Validation Set? Difference between supervised and unsupervised learning? Explain about data import in R language?

3+6+6

GROUP - B

Answer *any one* of the following: 1×10=10

5. Explain about logistic regression. Write about different functions for statistical distribution. 5+5

6. What are different ways to call a function in R? What is variable scope in R programming? 5+5

[Practical]

Answer *any one* of the following: 1×20=20

7. Write a program that prints a multiplication table for numbers up to 10.

8. Following table gives a frequency distribution of systolic blood pressure. Compute all the measures of dispersion.

Midpoint	95.5	110.5	120.5	125.5	130.5	145.5	165.5	175.5	195.5
Number	5	8	20	26	15	9	4	5	2

9. Obtain probability distribution of , where X is number of spots showing when a six-sided symmetric die (i.e. all six faces of the die are equally likely) is rolled. Simulate random samples of sizes 50, 60 and 100 respectively and verify the frequency interpretation of probability.

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Numerical Methods

[Theory]

Group - A

Answer *any two* of the following: 2×15=30

1. a) What is an error? State the differences between round-off error, truncation error and global truncation error. Give examples of each.

   b) Find the truncation error and the order of differentiation method.

   $$f'^{(x0)} = \frac{1}{2h} + [f(x0+h) - f(x0-h)$$

                                                                                        (2+8) + 5

2. a) Solve the following system of equations

   $$x_1 - x_2 + 3x_3 = 4$$

   $$2x_1 + x_2 + 4x_3 = 12$$

   $$3x_1 + 5x_2 - 2x_3 = 17$$

   by Gauss elimination method.

   b) Evaluate $\int_0^1 \frac{1}{(1+x^2)} dx$ by using trapezoidal rule with h = 0.5 and h = 0.25. Use Romberg's method to find the best value of it.   8 + 7

3. a) Use Newton's divided difference interpolation to approximate the value of f(5) from the following data:

x	F(x)
1	0
3	2
4	1
6	-1
7	4

b) Use the classical Runge-Kutta fourth order method to find the approximate value of y at x = 1.1 for $\frac{dy}{dx} = \frac{x}{y}$, y(1) = 2, h = 0.1.

7 + 8

4. a) Use the Gauss-Seidel iteration scheme in matrix form to solve the given system of equations.

$[-2154 - 814 - 1 - 2][xyz] = [15 - 21 - 2]$

Also, find whether the scheme converges or not.

b) Solve $\frac{dy}{dx} = \frac{y-x}{y+x}$, with y(0) = 1 using Euler's method in the interval [0, 0.04] by dividing the interval into 2 sub-intervals. 8 + 7

GROUP - B

Answer *any one* of the following: 1×10=10

5. a) Find a real root of the equation f(x) = x^3+ x - 5 = 0 by the bisection method, correct to first decimal place.

b) Use Lagrange's interpolation method to estimate the value of f(3) from the following:

x	F(x)
2	3
5	1
6	2
7	6

5 + 5

6. a) Perform three iterations of Newton-Raphson method to find the root of the equation x^4 - x + 1= 0 with initial approximation x0= 0.

b) A curve passes through the points (1, 0.2), (2, 0.7), (3, 1), (4, 1.3), (5, 1.5), (6, 1.7), (7, 1.9), (8, 2.1), (9, 2.3). Find the area bounded by the curve, x-axis, x = 1 and 1 x = 9 using Simpson's 1/3 rule.

5 + 5

[Practical]

Answer ***any one*** of the following: 1×20=20

7. Write a program in any programming software Matlab / Mathematica / Maple to find the solution of the following problem by Simpson's 1/3 rule:

$$\int_0^1 e^x \, dx$$

8. Write a program in any programming software Matlab / Mathematica / Maple to find the roots of the following equation by Newton's method:

$$f(x) = x^2 - 612$$

9. Write a program in any programming software Matlab / Mathematica / Maple to find the solution of system of equations using Jacobi method:

$$5x_1 - 2x_2 + 3x_3 = -1$$

$$-3x_1 + 9x_2 + x_3 = 2$$

$$2x_1 - x_2 - 7x_3 = 3$$

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