Programme	BS Computational Statistics and Data Analytics	Course Code	CSTA-306	Credit Hours	3
Course Title	Image Analysis				

Course Introduction

This course provides a deep dive into the theory and practice of manipulating digital images for analysis and enhancement. Students will explore techniques such as filtering, edge detection, and image segmentation, gaining the skills to extract meaningful information from images in fields like medicine, remote sensing, and multimedia. Hands-on projects and real-world applications provide practical experience in this essential field of computer vision.

Learning Outcomes

By the end of this course, students will be able to:

1. Get familiar with both the theoretical and practical aspects of computing with images.
2. Have described the foundation of image formation, measurement, and analysis.
3. Have implemented common methods for robust image matching and alignment.
4. Understand the geometric relationships between 2D images and the 3D world.

Course Content		Assignments/Readings
Week 1	**Unit – I** Digital Image Fundamentals: Introduction to digital images: representation, sampling, and quantization	
	Unit – II Image acquisition process and basic relationships between pixels	
Week 2	**Unit – III** Understanding imaging geometry and its importance in digital image processing	
	Unit – IV Image Transforms: Introduction to image transforms: discrete Fourier transform (DFT) and its applications in image processing	
Week 3	**Unit – V** Discrete cosine transform (DCT) and its use in image compression and transformation	
	Unit – VI Overview of Walsh and Hadamard Transform, Hotelling Transform	
Week 4	**Unit – VII** Overview of Walsh transforms	
	Unit – VIII Importance of Walsh transforms in image processing	
Week 5	**Unit – IX** Overview of Hadamard transforms	

	Unit – X Importance of Hadmard transforms in image processing	
Week 6	**Unit – XI** Introduction to the Hotelling transform	
	Unit – XII Application of Hotelling transform in image analysis	
Week 7	**Unit – XIII** Image Enhancement: Techniques for enhancing images in both spatial and frequency domains	
	Unit – XIV Methods for improving image quality, contrast, and sharpness	
Week 8	**Unit – XV** Image Smoothing and Sharpening: Understanding image smoothing techniques to reduce noise and blur	
	Unit – XVI Image sharpening methods for enhancing edge details and improving image clarity	
Week 9	**Unit – XVII** Image Restoration: Introduction to image restoration techniques and degradation models	
	Unit – XVIII Understanding inverse filtering and its limitations in image restoration	
Week 10	**Unit – XIX** Wiener Filter: Overview of the Wiener filter and its applications in image restoration and noise reduction	
	Unit – XX Understanding the principles behind adaptive Wiener filtering for varying noise levels	
Week 11	**Unit – XXI** Color and Pseudo-Color Image Processing: Introduction to color models and color spaces in digital image processing	
	Unit – XXII Techniques for color enhancement and pseudo-coloring for visualization purposes	
Week 12	**Unit – XXIII** Image Segmentation: Understanding image segmentation	

	Unit – XXIV Importance of image segmentation in image analysis	
Week 13	**Unit – XXV** Techniques for detecting discontinuities and boundaries in images	
	Unit – XXVI Techniques for detecting discontinuities and boundaries in images Continued	
Week 14	**Unit – XXVII** Thresholding, Region-Oriented Segmentation: Overview of thresholding methods for image segmentation based on pixel intensity	
	Unit – XXVIII Region-oriented segmentation techniques for partitioning images into meaningful regions	
Week 15	**Unit – XXIX** Motion Analysis in Segmentation: Understanding the use of motion analysis techniques for dynamic image segmentation	
	Unit – XXX Applications of motion detection and tracking in video processing and surveillance systems	
Week 16	**Unit – XXXI** Advanced Topics in Image Segmentation: Exploration of advanced segmentation algorithms based on machine learning and deep learning approaches	
	Unit – XXXII Discussion of recent developments and applications in image segmentation techniques	

Textbooks and Reading Material

Text Book

1. Szeliski, R. (2010). *Computer vision: algorithms and applications*. Springer Science & Business Media.

Suggested Readings

1. Forsyth, D. A., & Ponce, J. (2003). *Computer vision: a modern approach*, *17*, 21-48.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning: data mining, inference, and prediction*. Springer Science & Business Media.

Teaching Learning Strategies

Class Lecture method, which includes seminars, discussions, assignments and projects. (Audio-visual tools are used where necessary)

Assignments: Types and Number with Calendar

According to the choice of respective teacher.			
Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Formative Assessment	25%	It is continuous assessment. It includes: Classroom participation, attendance, assignments, and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.