CS3242 Image Processing and Pattern Analysis

Course Coordinator:

Dr Vivek Singh Sikarwar
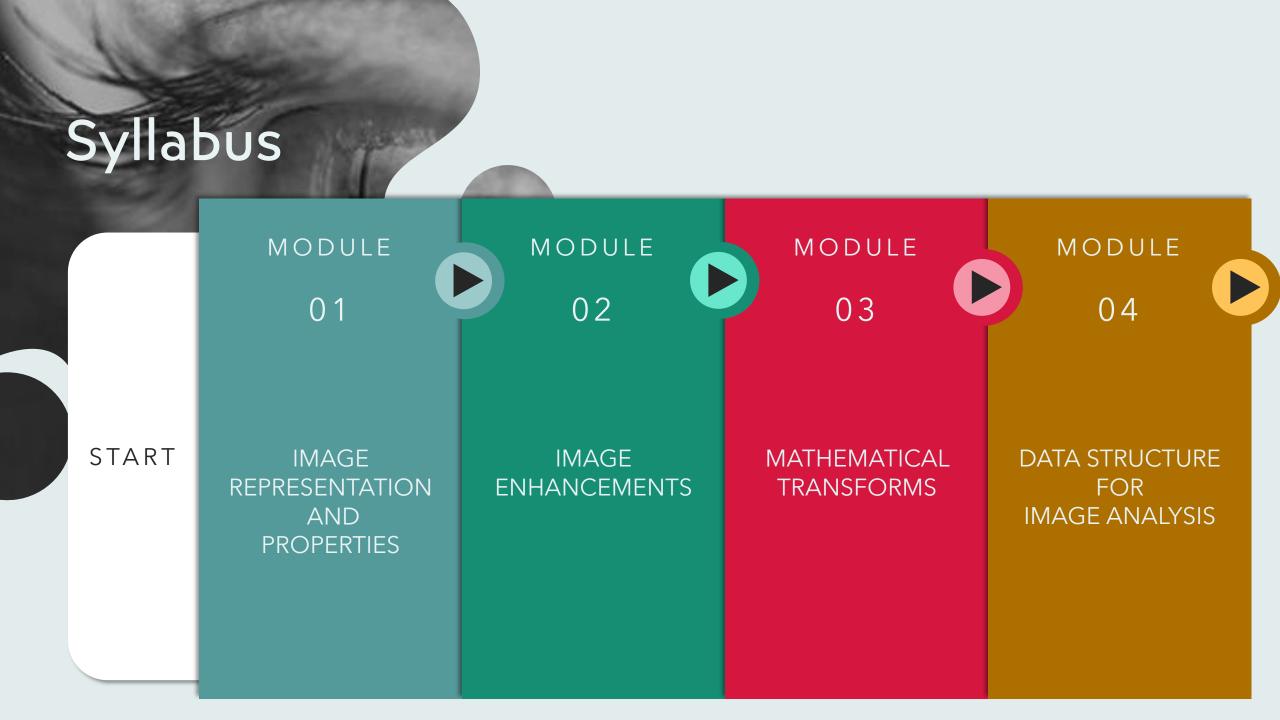
Course Instructor:

Kirti Paliwal

Introduction

Nowadays image processing and pattern analysis is becoming an important assisting tool in many branches of science such as computer science, electrical and electronic engineering, robotics, physics, chemistry, environmental science, biology, and psychology.

Due to this importance, it is good to increase your knowledge in image processing so that you can develop new ideas in that field or introduce a new application of computer vision in your research. The pattern analysis includes Bayes decision theory, learning parametric distributions, non-parametric methods, regression, SVD, support vector machines, principal components analysis, nonlinear dimension reduction, independent component analysis, K-means analysis, and probability models.
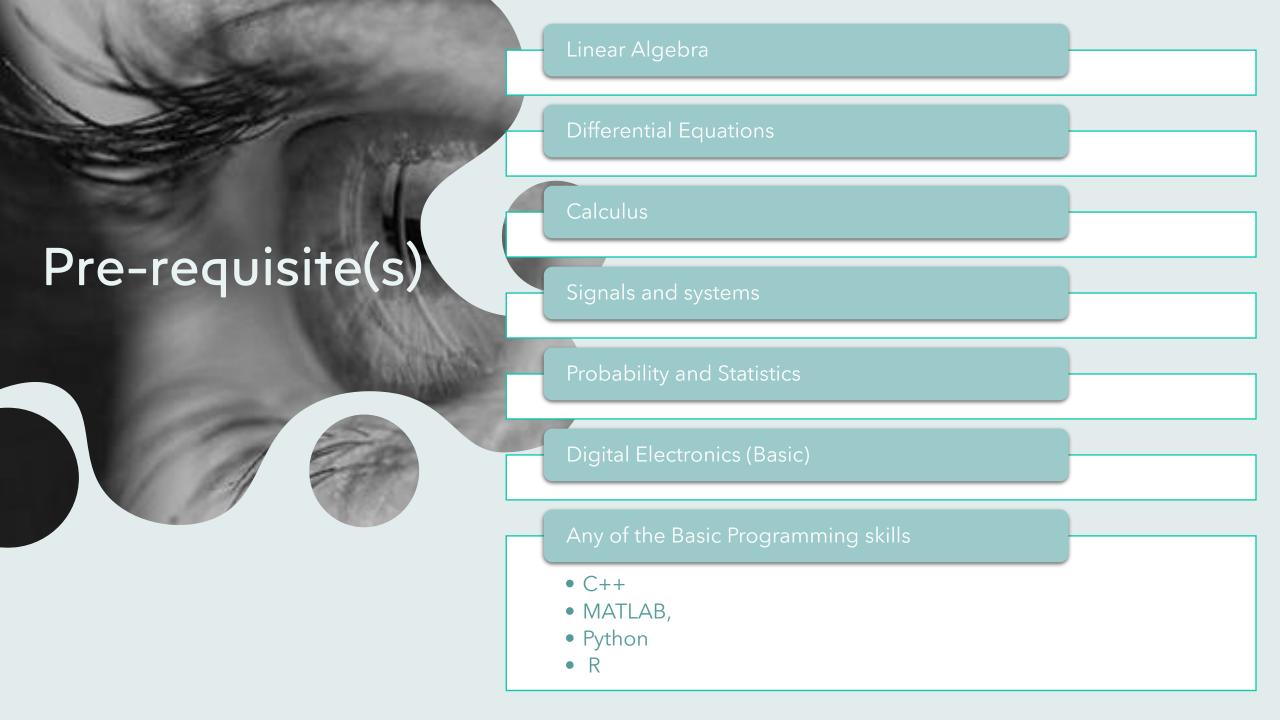
Course Outcomes

CS3242.1

Explain the basic ideas of image processing, process of image digitization, digital image properties, various image file formats, and illustrate the physics of color, human perception, different color spaces, and the principles of image sensing and acquisition

CS3242.2

Apply grayscale transformations, interpolation, histogram processing and employ Canny edge detection and corner detection algorithms in the analysis of images

CS3242.3

Apply mathematical transforms (Fourier, DFT, DCT, wavelet) to analyze the spatial and frequency domain representation of images to assess the significance of diverse data structures (matrices, chains, pyramids) in image analysis, implement spatial domain filtering for image restoration and image segmentation techniques and their representation schemes.

CS3242.4

Demonstrate image restoration techniques through inverse filtering, develop image segmentation algorithms relying on grey-level features and analyze contour-based and region-based descriptors, and construct image by algorithms employing SIFT, HOG, and morphological operations

CS3242.5

Analyze the effectiveness of frequency-domain filters for image enhancement, assess image segmentation methods' performance against specified criteria, critically evaluate the accuracy and efficiency of shape representation techniques, and evaluate the robustness of image understanding algorithms in diverse scenarios.

Syllabus

START

MODULE 01
IMAGE REPRESENTATION AND PROPERTIES

MODULE 02
IMAGE ENHANCEMENTS

MODULE 03
MATHEMATICAL TRANSFORMS

MODULE 04
DATA STRUCTURE FOR IMAGE ANALYSIS

Syllabus

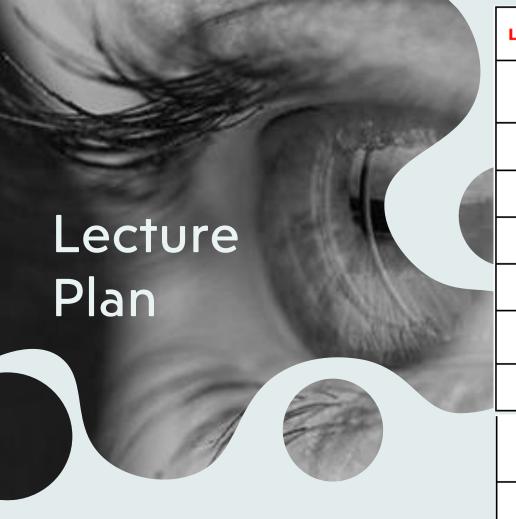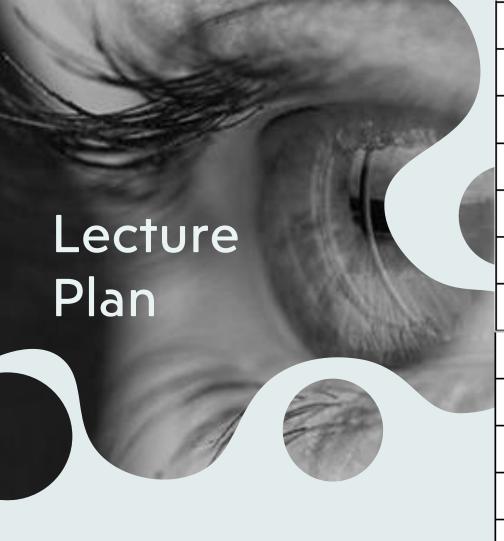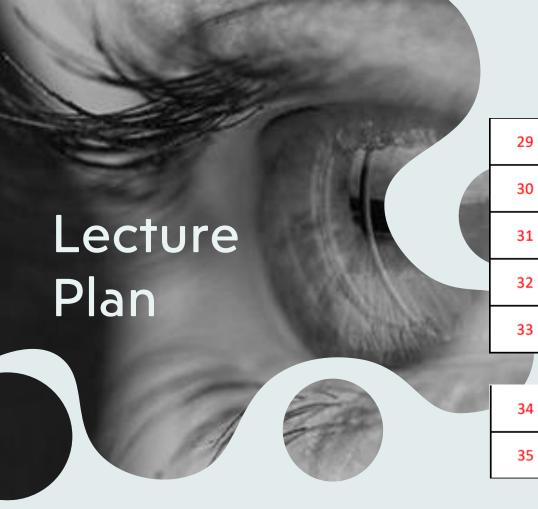| MODULE 05	MODULE 06	MODULE 07	MODULE 08	
IMAGE RESTORATION	IMAGE SEGMENTATION AND REPRESENTATION	SHAPE REPRESENTATION AND DESCRIPTION	IMAGE UNDERSTANDING	END

Pre-requisite(s)

Linear Algebra

Differential Equations

Calculus

Signals and systems

Probability and Statistics

Digital Electronics (Basic)

Any of the Basic Programming skills

- C++
- MATLAB,
- Python
- R

CWS Components

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	MTE	30
	Assignments /Quiz/Attendance (Accumulated and Averaged)	15+10+5 = 30
End Term Exam (Summative)	End Term Exam	40
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	

Lecture Plan

Lec. #	TOPICS	Mode of Delivery	Corresponding CO
1	Introduction to image processing and pattern analysis	PPT, Lecture, Class Notes	CS3242.1
2	Image representation and properties	PPT, Lecture, Class Notes	CS3242.1
3	Image processing steps	PPT, Lecture, Class Notes	CS3242.1
4	Image digitization, digital image properties	PPT, Lecture, Class Notes	CS3242.1
5	Metrics, histograms, entropy	PPT, Lecture, Class Notes	CS3242.1
6	Sampling and quantization	PPT, Lecture, Class Notes	CS3242.1
7	Image file formats, basic relationships between pixels	PPT, Lecture, Class Notes	CS3242.1
8	Physics of color, human perception, color spaces, image sensing and acquisition, monochromatic and color camera	PPT, Lecture, Class Notes	CS3242.1
9	**Image enhancements:** grayscale transformations	PPT, Lecture, Class Notes	CS3242.2
10	Brightness interpolation, histogram processing using arithmetic/logic operations	PPT, Lecture, Class Notes	CS3242.2
11	Smoothing spatial filters, sharpening spatial filters	PPT, Lecture, Class Notes	CS3242.2
12	Canny edge detection, detection of corners (interest points).	PPT, Lecture, Class Notes	CS3242.2
13	**Mathematical transforms:** linearity	PPT, Lecture, Class Notes	CS3242.2

Lecture Plan

14	Convolution, linear integral transform	PPT, Lecture, Class Notes	CS3242.2
15	Fourier transform, DFT	PPT, Lecture, Class Notes	CS3242.3
16	DCT, wavelet transform	PPT, Lecture, Class Notes	CS3242.3
17	SVD	PPT, Lecture, Class Notes	CS3242.3
18	PCA	PPT, Lecture, Class Notes	CS3242.3
19	Smoothing frequency-domain filters, sharpening frequency domain filters	PPT, Lecture, Class Notes	CS3242.3
20	**Data structure for image analysis:** matrices	PPT, Lecture, Class Notes	CS3242.3
21	Relational structures, pyramid, quadtree	PPT, Lecture, Class Notes	CS3242.3
22	**Image restoration:** various noise models	PPT, Lecture, Class Notes	CS3242.3
23	Image restoration using spatial domain filtering, estimating the degradation function	PPT, Lecture, Class Notes	CS3242.3
24	Inverse filtering, wiener filtering	PPT, Lecture, Class Notes	CS3242.4
25	**Image segmentation and representation:** grey level features, edges and lines, similarity	PPT, Lecture, Class Notes	CS3242.4
26	Correlation, thresholding, template matching	PPT, Lecture, Class Notes	CS3242.4
27	Edge-based segmentation, region-based segmentation, representation scheme, evaluation issues	PPT, Lecture, Class Notes	CS3242.4
28	Mean shift segmentation, graph cut segmentation	PPT, Lecture, Class Notes	CS3242.4

Lecture Plan

29	**Shape representation and description:** contour-based Analysis	PPT, Lecture, Class Notes	CS3242.4
30	Connected Component Analysis, chain code	PPT, Lecture, Class Notes	CS3242.5
31	B-spline representation, region-based	PPT, Lecture, Class Notes	CS3242.5
32	Moments, convex hull	PPT, Lecture, Class Notes	CS3242.5
33	**Image understanding:** scale invariant feature transform (SIFT)	PPT, Lecture, Class Notes	CS3242.5

34	Histograms of oriented gradient (HOG)	PPT, Lecture, Class Notes	CS3242.5
35	Image morphology, dilation and erosion, skeleton	PPT, Lecture, Class Notes	CS3242.5

Thank You !