Title of the Course	**Vision Intelligence and Machine Learning**

Credits	T: 3, P: 1, E: 0, C: 4
Course Type (Theory/Practical/Integrated)	Integrated
Course Category	Core Discipline
Pre-Requisite	1. Basic proficiency in Python programming 2. Foundational knowledge of linear algebra, probability and statistics 3. Introductory machine learning (classification and regression), and basic neural network concepts.
Learning Objectives	1. Understand the fundamentals of image formation, camera geometry, and multi-resolution image representations used in computer vision. 2. Analyse and extract meaningful image features using edge detection, geometric transformations, and projective models. 3. Apply geometric vision techniques such as Structure from Motion, stereo vision, and optical flow for 3D reconstruction and motion estimation. 4. Employ machine learning methods including regression, classification, and SVMs for object recognition tasks. 5. Build and interpret convolutional neural network models for image classification and visual understanding applications
Course Outcomes & Bloom's Level	

CO Code	**Course Outcome Statement**	**Bloom Level**
CO1	Explain principles of image formation, frequency characteristics, and multi-resolution image analysis techniques.	L2
CO2	Analyse image features and geometric transformations for feature detection and correspondence estimation.	L4
CO3	Apply projective geometry, Structure from Motion, stereo vision, and optical flow techniques to visual reconstruction problems.	L3
CO4	Apply probabilistic, regression, and classification techniques for visual understanding and recognition tasks.	L3
CO5	Evaluate object recognition approaches using Support Vector Machines and feature-based methods.	L5

	CO6	Design convolutional neural network models for image classification and vision-based applications.	L6
Course Elements	**Course Element**	**Coverage Level**	
	Skill Development	Yes	
	Entrepreneurship	No	
	Employability	Yes	
	Professional Ethics	Yes	
	Gender	No	
	Human Values	No	
	Environment & Sustainability	No	
SDG (Goals)	SDG 4: Quality Education		
Total Hours of Pedagogy	45 hours Theory (15 hours Self-paced content + 30 hours lecture) 30 hours Practical		

Module#	Content	Pedagogy
M-1	**Image Formation** Image acquisition, camera geometry, colour sensing; Frequency characteristics	Self-paced content, Lecture, Modular Assignment
M-2	**Multiresolution Pyramids** Gaussian and Laplacian pyramids; Wavelet	Self-paced content, Lecture, Modular Assignment
M-3	**Image Features** Feature detection, description and matching; Edge detection, line detection	Self-paced content, Lecture, Modular Assignment
M-4	**Geometric Transformations, Affine Transformations, Projective and Random Sample Consensus (RANSAC)** Projective geometry and transformations; Estimation of projective transformations, RANSAC	Self-paced content, Lecture, Modular Assignment
M-5	**Structure from Motion (SfM)** Camera models, epipolar geometry and the fundamental matrix, correspondences estimation; Triangulation, 3D reconstruction of cameras and structure, bundle adjustment	Self-paced content, Lecture, Modular Assignment
M-6	**Optical Flow Estimation** Optical flow; Frame interpolation, motion compression	Self-paced content, Lecture,

		Modular Assignment
M-7	**Image Stitching (Mosaicing)** Global alignment; Compositing	Self-paced content, Lecture, Modular Assignment
M-8	**Image Morphing, Blending and Carving** Image morphing; Image blending (image stitching, mosaicing) and carving	Self-paced content, Lecture, Modular Assignment
M-9	**Stereo** Single camera geometry (homogeneous coordinates, perspective projection model, and camera calibration); Stereo reconstruction (epipolar geometry, stereo correspondence, triangulation)	Self-paced content, Lecture, Modular Assignment
M-10	**Probability and Statistics, Regression and Classification** Revision of techniques from probability and statistics useful in visual understanding of tasks; Classification vs. regression, basic algorithms	Self-paced content, Lecture, Modular Assignment
M-11	**Support Vector Machine (SVM) and Object Recognition** Support Vector Machine (SVM) and Object bject recognition methods (alignment and appearance based, feature based, part and shape based); SVM overview, linear vs. non-linear SVM, binary-class vs. multi-class SVM, application to object recognition	Self-paced content, Lecture, Modular Assignment
M-12	**Convolutional Neural Network (CNN)** Artificial neural network (perceptron, nonlinearity, feedforward model); Convolution operation, composition of convolutions, application in image classification	Self-paced content, Lecture, Modular Assignment

List of DIY Modular Assignments

1. Basic Image Processing - Image Formation and Feature in Python
2. Geometrical Transformations, Affine, Projective and RANSAC
3. Optical Flow Estimation - Frame Interpolation and Motion Compression
4. Image Stitching, Morphing, and Carving
5. Stereo, Single Camera Geometry, Stereo Reconstruction
6. SVM and Object Recognition
7. Image Classification using Convolutional Neural Networks (CNNs)
8. Object detection / semantic segmentation using pretrained CNN models

Modular Assignment Mapping

S. No.	*DIY Assignment Title*	*Mapped CO(s)*	*Bloom Level*
1	Basic Image Processing – Image Formation and Feature in Python	CO1, CO2	L3

2	Geometrical Transformations, Affine, Projective and RANSAC	CO2	L4
3	Optical Flow Estimation – Frame Interpolation and Motion Compression	CO3	L3
4	Image Stitching, Morphing, and Carving	CO3	L4
5	Stereo, Single Camera Geometry, Stereo Reconstruction	CO3	L4
6	SVM and Object Recognition	CO4, CO5	L5
7	Image Classification using Convolutional Neural Networks (CNNs)	CO6	L3
8	Object Detection / Semantic Segmentation using Pretrained CNN Models	CO6	L6

Reference Books	1. **Richard Szeliski**, *Computer Vision: Algorithms and Applications*, 2nd Edition, Springer, 2022. 2. **Rafael C. Gonzalez and Richard E. Woods**, *Digital Image Processing*, 4th Edition, Pearson Education, 2018. 3. **David A. Forsyth and Jean Ponce**, *Computer Vision: A Modern Approach*, 2nd Edition, Pearson Education, 2012. 4. **Christopher M. Bishop**, *Pattern Recognition and Machine Learning*, 1st Edition, Springer, 2006.

Course Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	-	-	2
CO2	2	3	-	2	2	-	-	-	-	-	-	2
CO3	2	3	2	3	2	-	-	-	1	-	-	2
CO4	2	2	2	-	3	-	-	-	-	-	-	2
CO5	2	2	-	2	3	-	-	-	-	-	-	2
CO6	2	2	3	2	3	-	-	-	2	2	-	2