1. Course Information					
1.1	**Course Name:**	Computer Vision		**1.2: Course Code:**	CS570
1.3	**Credit Hours:**	3		**1.4: Contact Hours:**	3
1.5	**Pre-requisites:**	Probability & Statistics, Linear Algebra			
1.6	**Course Introduction:** Human beings (and even animals) "look" at the real-world and extract extremely accurate information extremely efficiently. Computers can fail catastrophically at this task! In this course we look into why "vision" is a difficult problem to solve and we go through successful, mathematically well-founded techniques used to solve the vision problem. Computer vision tries to make computers “see”. It is an inter-disciplinary area covering physics, biology, neuroscience, arts, and computer science. The course will have two main goals: to understand how visual perception works and to build systems that can interpret the world around them using images.				
1.7	**Course Outline:** Foundations of Computer Vision, Looking at Images, Computer Vision and Society; Image Formation, Lenses, Cameras as Linear Systems, Color; Foundations of Learning, Gradient-Based Learning, Generalization, Neural Networks; Foundations of Image processing; Image Filtering, Linear Filters, Blur Filters, Image Derivatives; Sampling and Multiscale Image Representations, Filter Banks, Image Pyramids; Neural Architectures for Vision, Convoutional Neural Networks, Transformers, Dataset Bias and Robust Learning, Transfer Learning and Adaptation; Understanding Geometry, Representing Images and Geometry, Camera Modelling and Calibration, Stereo Vision, Homographies, Single View Metrology, Learning to Estimate Depth from a Single Image, Multiview Geometry and Structure from Motion; Understanding Motion, Optic Flow; Object Recognition				
1.8	**Additional Content:**				

2. Unit-wise Major Topics

2.1	Unit No.	2.2 Topic Course Outline divided into topics	2.3 Teaching Hours
2.1.1	U1	Foundations of Computer Vision	3
2.1.2	U2	Image Formation	3
2.1.3	U3	Foundations of Learning	4.5
2.1.4	U4	Foundations of Image processing	3
2.1.5	U5	Linear Filters	3
2.1.6	U6	Sampling and Multiscale Image Representations	4.5
2.1.7	U7	Neural Architectures for Vision	7.5
2.1.8	U8	Understanding Geometry	10.5
2.1.9	U9	Understanding Motion	3
2.1.10	U10	Object Recognition	3
		Total Teaching Hours:	**45**

3. Mapping of each Course Learning Outcomes (CLOs) to (a) Unit Nos., (b) Bloom's Taxonomy, and (c) Program Level Outcomes (PLOs).

3.1	CLO No.	3.2 Course Learning Outcomes (CLOs) Description	2.1 Unit No.	3.3 Bloom's Taxonomy	3.4 PLOs
3.1.1 CLOs for Theory					
3.1.1.1	CLO-1	Understanding the foundations of image formation, image perception and computer vision	U1, U2	C2 (Understand)	2-5, 9
3.1.1.2	CLO-2	Understanding the foundations of machine learning for computer vision	U3, U7, U10	C2 (Understand)	2-5
3.1.1.3	CLO-3	Understanding the fundamentals of image processing	U4, U5, U6	C2 (Understand)	2-5
3.1.1.4	CLO-4	Understanding single and multi-view geomtery	U8	C2 (Understand)	2-5
3.1.1.5	CLO-5	Understanding motion	U9	C2 (Understand)	2-5
3.1.1.6	CLO-6	Apply concepts of CV for solving real world problems	U3 - U10	C3 (Apply)	3-7
3.1.2 CLOs for Lab					

4. CLO Assessment Mechanism							
		3.1.1 CLOs for Theory					
		3.1.1.1	3.1.1.2	3.1.1.3	3.1.1.4	3.1.1.5	3.1.1.6
4.1	Assessment Tools	CLO-1	CLO-2	CLO-3	CLO-4	CLO-5	CLO-6
4.1.1	Quiz	Quiz 1	Quiz 2, 4	Quiz 3	Quiz 5, 6		
4.1.2	Assignment / H.W.		Assign. 1, 3	Assign. 2	Assign. 4, 5		Assign. 1-5
4.1.3	Project						
4.1.4	Mid-term Exam	Mid-Term Exam	Mid-Term Exam	Mid-Term Exam			
4.1.5	Final-term Exam	Final-term Exam					

5. Reading Material		
5.1	Textbook:	1. Foundations of Computer Vision, Antonio Torralba, Philip Isola, William T. Freeman, MIT Press, 2024
5.2	Reference Books:	1. Computer Vision: Algorithms and Applications, 2nd Edition, Richard Szeliski, The University of Washington, 2022
		2. Multiple View Geometry in Computer Vision, by Richard Hartley and Andrew Zisserman.
		3. Digital Image Processing, 4th Edition, Rafael Gonzalez and Richard Woods, Pearson, 2018.

6. Lecture-wise Plan				
6.1	2.1	6.2	6.3	6.4
Lecture No.	Unit No.	Topics Covered	Reading Material	Quiz/Assign /Project
1.	U1	Introduction	Torralba Ch 1	
2.	U1	Looking at Images + Computer Vision and Society	Torralba Ch 3, 4	
3.	U2	Image formation and Lenses	Torralba Ch 5, 6	
4.	U2	Cameras as Linear Systems + Color	Torralba Ch 7, 8	Quiz 1

5.	**U3**	Introduction to Machine Learning	Torralba Ch 9	
6.	**U3**	Gradient-Based Learning + Generalization	Torralba Ch 10, 11	
7.	**U3**	Neural Networks	Torralba Ch 12, 13	
8.	**U4**	Linear Image Filtering	Torralba Ch 15	Quiz 2
9.	**U4**	Fourier Analysis	Torralba Ch 16	Assignment 1
10.	**U5**	Blur Filters	Torralba Ch 17	
11.	**U5**	Image Derivatives	Torralba Ch 18	
12.	**U6**	Image Sampling	Torralba Ch 20, 21	Quiz 3
13.	**U6**	Filter Banks	Torralba Ch 22	
14.	**U6**	Image Pyramids	Torralba Ch 23	Assignment 2
15.	**U7**	Convolutional Neural Networks	Torralba Ch 24	
16.	**U7**	Transformers	Torralba Ch 26	
17.	**Mid-term Exam**			
18.				
19.	**U7**	Perceptual Grouping	Torralba Ch 31	
20.	**U7**	Dataset Bias and Robust Learning	Torralba Ch 35, 36	
21.	**U7**	Transfer Learning and Adaptation	Torralba Ch 37	Assignment 3
22.	**U8**	Representing Images and Geometry	Torralba Ch 38	Quiz 4
23.	**U8**	Camera Modelling and Calibration	Torralba Ch 39	
24.	**U8**	Stereo Vision	Torralba Ch 40	
25.	**U8**	Homographies	Torralba Ch 41	Assignment 4
26.	**U8**	Single View Metrology	Torralba Ch 42	Quiz 5
27.	**U8**	Learning to Estimate Depth from a Single Image	Torralba Ch 43	
28.	**U8**	Multiview Geometry and Structure from Motion	Torralba Ch 44	Assignment 5
29.	**U9**	Motion Estimation	Torralba Ch 46, 47	Quiz 6
30.	**U9**	Optic Flow	Torralba Ch 48, 49	
31.	**U10**	Object Recognition	Torralba Ch 50	
32.		Conclusion		
Final-term Exam				