COURSE DESCRIPTION FORM: <u>CS4059 Fundamental of Computer Vision</u>

COURSE DESCRIPTION FORM

INSTITUTION   FAST School of Computing, National University of Computer and Emerging Sciences, Karachi

PROGRAM TO BE EVALUATED	BS-CS– Spring 2023

Course Description

Course Code	CS4059
Course Title	Fundamental of Computer Vision
Credit Hours	3
Prerequisites by Course(s) and Topics	
Grading Policy	
Policy about missed assessment items in the course	Retake of missed assessment items (other than midterm/ final exam) will not be held. For a missed midterm/ final exam, an exam re-take/ pre-take application along with necessary evidence are required to be submitted to the department secretary. The examination assessment and retake committee will decide the exam re-take/ pre-take cases.
Course Plagiarism Policy	Plagiarism in project or midterm/ final exam may result in F grade in the course. Plagiarism in an assignment will result in zero marks in the **whole assignments** category.
Assessment Instruments with Weights (homework, quizzes, midterms, final, programming assignments, lab work, etc.)	*75% Theory 25% Practical* Assessment Items <table><tr><th>Assessment Item</th><th>Number</th><th>Weight (%)</th></tr><tr><td>Assignments + Quizzes</td><td>3+3</td><td>5+5</td></tr><tr><td>Midterm Exam</td><td>2</td><td>10 each</td></tr><tr><td>Computer Vision Challenging Task</td><td>1</td><td>10</td></tr><tr><td>Project (Theory)</td><td>1</td><td>10</td></tr><tr><td>Final Exam</td><td>1</td><td>50</td></tr></table>
Course Instructors	
Lab Instructors (if any)	
Course Coordinator	Dr. Muhammad Farrukh Shahid
URL (if any)	

NCEAC.FORM.001-D

Current Catalog Description	Provide the student with knowledge of the theories and applications of image processing and machine vision. Familiarize the student with some important concepts and analytical techniques for linear and non-linear image processing. Give the student some experience in the development of image processing applications and research using Python, OpenCV and other Python libraries for numeric processing Familiarize the student with a broad range of operators and processing techniques for image reconstruction, filtering, enhancement, expansion, motion estimation, optic flow, image classification and video processing
Textbook (or **Laboratory Manual** for Laboratory Courses)	Computer Vision: Algorithms and ApplicationsSecond Edition Richard Szeliski Springer Nature Switzerland AG, 2022
Reference Material	Computer Vision: Principles, Algorithms, Applications, Learning E.R. Davies Academic Press, Elsevier Inc., 2018

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Course Learning Outcomes

PLO	Program Learning Outcome (PLO) Statement
PLO3	Design/Develop Solutions Design solutions for complex computing problems and design systems, components, and processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PLO5	Modern Tool Usage Create, select, and apply appropriate techniques, resources and modern computing tools, including prediction and modelling for complex computing problems.

CLO	Course Learning Outcome (CLO)	Domain	Taxonomy Level	PLO	Tools
01	Understand the theories and methods in image processing and computer vision	Cognitive	3	5	A2, M1, F
02	Formulate, and solve problems in image processing and computer vision	Cognitive	5	5	A1, Q2, M1, M2, F
03	Analyse, evaluate and examine classical computer vision systems	Cognitive	5	3	A3, Q2, M2, F
04	Analyse, evaluate and examine latest computer vision systems	Cognitive	5	3	A4, CCP, F4

Tool: A = Assignment, Q = Quiz, M = Midterm, F=Final, CCP = Complex Engineering Problem.

	Topics to be covered				
	List of Topics	**Week**	**No. of Weeks**	**Contact Hours**	**CLO(s)**
Topics covered in the course with number of lectures on each topic (Assume 15 weeks of instruction and 1 hour lecture duration)	**Introduction**: Introduction to the Course *(1 Lecture)* --- The roadmap of the Computer Vision *(1 Lecture)* --- *Formal Definition of CV and its application, history, and latest trends in CV (1 Lecture)*	1	1	3	1
	Image Formation, Image representation, (*1 Lecture*) --- Geometric primitives and transformations, Photometric image formation, *(1 Lecture)* --- The digital Camera orientation *(1 Lecture)* **Assignment no 1 Release (End of Week 2)**	2	1	3	1,2,3
	--- RGB/Grayscale, Otsu/K-means thresholding (2 Lecture) --- Histogram equalization, Matte and Compositing (1 Lecture)	3	1	3	1,2,3
	Image processing **(1 Lecture)** --- Linear filtering, More neighborhood operators, (1 Lecture) --- Fourier transforms, Pyramids, and wavelets, **(1 Lecture)** **Assignment no 1 Submission (End of Week 4)**	4	1	3	1,2,3

	Geometric transformations, Global optimization *(2 Lectures)* -- Separable filtering, SVD, PCA *(1 Lecture)*	5	1	3	
	WEEK 6	*MID -1 Exam*			
	SVD, PCA *(1 Lecture)* -- Distance transform, Binary image processing/Morphological Image Processing (*2 Lectures)* **Assignment no 2 Release (Start of Week 7)**	7	1	3	2,3
	Viola-Jones Algorithm, Integral image, Haar features *(1 Lecture)* Hough transform, gradient images, *(2 Lecture)* --	8	1	3	2,3
	Histogram of Oriented Gradients HoG, *(1 Lecture)* SIFT, Blob detection in computer vision. *(2 Lecture)* -- **Assignment no 2 Submission (End of Week 9)**	9	1	3	2,3
	Introduction to Image Classification *(1 Lectures)* -- Image Classification models *(1 Lecture)* Simple CNN model for classification *(1 Lecture)*	10	1	3	

	Week 11	*MID -2 Exam*			
	Modern Classification models Alexnet, GoogleNet *(3 Lectures)* **Assignment no 3 Release (Start of Week 12)**	**12**	**1**	**3**	**2,3**
	Image detection Introduction to Single stage and Double Stage detectors *(3 Lectures)*	**13**	**1**	**3**	**2,3**
	YOLO model, R-CNN model. *(3 Lectures)* **Assignment no 3 Submission (Start of Week 14)**	**14**	**1**	**3**	**1,2**
	Revision	**15**	**1**	**3**	
	Week 16	*Final Exam*			
	Review		**1**	**3**	**1,2,3**
	Total		**16**	**48**	

Laboratory Projects/Experiments Done in the Course	
Programming Assignments Done in the Course	All the assignments would be programming based (e.g., C++, Java, Python, Open CV)

Class Time Spent (in percentage)	Theory (%)	Problem Analysis (%)	Solution Design (%)	Social and Ethical Issues (%)
	50	25	20	5

Oral and Written Communications	Every student is required to submit at least 1 written report of typically 10 pages in IEEE research report format. Students will also be called for viva/presentation of the project and any assignment where necessary.