| Logo Fast | **NATIONAL UNIVERSITY**  **of Computer & Emerging Sciences, Lahore** |
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Department of Computer Science

**CS4059 Fundamentals of Computer Vision**

**Spring 2025**

**Instructor Name:** Muhammad Amir Iqbal **TA Name (if any):**

**Email address:** amir.iqbal@nu.edu.pk **Email address:**

**Office Location/Number:**

**Office Hours:** Tue, Thu - 10 AM to 11:30 AM

**Course Information**

**Program:** BS **Credit Hours:** 3 **Type:** CS Elective

**Pre-requisites (if any):**

**Course Website (if any): Google Classroom**

**Class Time:**

**BCS-8A Tuesday Thursday 8:30-9:50 NB-203**

**BCS-8B Tuesday Thursday 11:30-12:50 NB-209, NB-302**

**Course Description/Objectives/Goals:**

This course introduces the core concepts of computer vision including both model-based and learning-based approaches. Students will explore the fundamentals of image analysis, neural networks, and representation learning, progressing to advanced topics like object detection, generative models, and vision-based challenges. The course combines theoretical foundations with practical applications, preparing students to tackle real-world problems in computer vision.

**Course Textbook(s)**

1. Foundations of Computer Vision, Antonio Torralba, Philip Isola, William T. Freeman, MIT Press, 2024
2. Computer Vision: Algorithms and Applications, 2nd Edition, Richard Szeliski, The University of Washington, 2022
3. Digital Image Processing, 4th Edition, Rafael Gonzalez and Richard Woods, Pearson, 2018.

**Course Learning Outcomes (CLOs)**

| CLO # | CLO description | BT Cognitive Level | PLO # |
| --- | --- | --- | --- |
| CLO 1 | 1. Understanding the foundations of image formation, image perception and color | 3 (Understanding) | PLO 2 |
| CLO 2 | 2. Understanding the foundations of learning-based computer vision | 3 (Understanding) | PLO 2,3 |
| CLO 3 | 3. Understanding the foundations of model-based computer vision | 3 (Understanding) | PLO 2,3 |
| CLO 4 | 4. Applying concepts of computer vision for solving real-world problems | 2 (Applying) | PLO 3,4 |

**Relevant Program Learning Outcomes (PLOs)**

| PLO # | PLO Name | PLO Description |
| --- | --- | --- |
| PLO 2 | Knowledge for Solving Computing Problems | Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements |
| PLO 3 | Problem Analysis | Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines |
| PLO 4 | Design/ Development of Solutions | Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations |

**Tentative Weekly Schedule**

| **S#** | **Topic** | **Week(s)** | **[[1]](#footnote-0)Readings** | **Learnings & Assessments** |
| --- | --- | --- | --- | --- |
| 1 | Introduction |  | [1] Chapter 1,2 | Setup python environment for CV |
| 2 | Looking at Images + Computer Vision and Society |  | [1] Chapter 3,4 |  |
| 3 | Image Formation and Lenses |  | [1] Chapter 5,6 | Practice: Working with OpenCV |
| 4 | Color |  | [1] Chapter 8 | Practice: Color Spaces using OpenCV |
| 5 | Introduction Learning |  | [1] Chapter 9 | Assignment 1 |
| 6 | Gradient-based Learning + Generalization |  | [1] Chapter 10,11 | Practice: Linear Regression with sklearn |
| 7 | Neural Networks |  | [1] Chapter 12,13 | Practice: Neural Networks with TensorFlow |
|  | Back Propagation |  | [1] Chapter 14 | Assignment 2 |
| 8 | Linear Image Filtering |  | [1] Chapter 15 | Practice: Applying Convolution |
| 9 | Mid 1 |  |  |  |
| 10 | Convolutional Neural Networks |  | [1] Chapter 24 |  |
|  | Recurrent Neural Nets |  | [1] Chapter 25 | Assignment 3 |
| 11 | Transformers |  | [1] Chapter 26 |  |
| 12 | Representation learning |  | [1] Chapter 30 |  |
|  | Mid 2 |  |  |  |
| 13 | CHALLENGES IN LEARNING-BASED VISION |  | [1] Chapter 35,36,37 | Assignment 4 |
| 14 | UNDERSTANDING GEOMETRY |  | [1] Chapter 38-42 |  |
| 15 | Image Classification  • Architectures (AlexNet, VGG) |  |  |  |
| 16 | Object Detection  • RCNN, YOLO |  |  |  |
| 17 | Generative Models  Generative Adversarial Network (GANs) |  |  |  |
|  |  |  |  |  |

**Grading Criteria - Relative**

Assignments/Project/Presentation/Quizzes/Class Activities: 50

Mid Exams, Final Exam: 10+10+30

**Course Policies**

**Announcements**

Announcements related to different aspects of this course (e.g. lectures, quizzes, exams, etc.) will be posted on google classroom, students are expected to check regularly.

**Attendance**

All students are expected to attend all lectures from beginning to end. Partial or full absence from a lecture may hamper chances for securing good grades.

**Exams**

Exams will be closed-book and closed-notes. Syllabus for the final exam will be comprehensive.

**Office Hours**

Students are encouraged to take full advantage of the instructor's office hours. Any doubts regarding concepts covered in class or any questions regarding quizzes, projects, etc. may be clarified during office hours. In case a student is not able to make it during office hours, he/she may schedule an appointment with the instructor for another time slot.

**Quizzes**

Quizzes may be announced or unannounced. A quiz will usually be about 5 – 10 minutes long and it may be given anytime during the lecture.

**Reading Material**

Students are encouraged to finish the assigned readings BEFORE the lecture. This is likely to improve lecture comprehension and class participation.

**Revision of Grades**

Students can contest their grades on quizzes and project deliverables ONLY within a week of the release of grades. Exams will be available for review according to university policies.

**Unfair Means**

Students are expected to demonstrate the highest degree of moral and ethical conduct. Any student caught cheating, copying, plagiarizing, or using any other unfair means will be strictly dealt-with in accordance with university policies.

1. Numbers in square brackets correspond to books numbered in the “Reference Material” section. [↑](#footnote-ref-0)