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| IQRA University (IU) | | |
| Faculty of Engineering Sciences and Technology (FEST) | | |
| Computer Science Department (CS) | | |
| Course Code | Course Name | Credit Hr |
| AIE423 | COMPUTER VISION | 2+1 |

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| 1. Basic Information | | | |
| Instructor | Dr. Lubna Aziz | Designation | Assistant professor (Head of AI) |
| Prerequisite(s) | AIC 221/AIC211 | Semester | Fall 2024 |
| Email | Lubna.aziz@iqra.edu.pk | Phone | NA |
| Consulting Hours | Friday(12:00 – 14:00) | Office Location | First Floor Faculty offices |

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| 1. **Course Objective(s)** |
| This course aims to provide a comprehensive understanding of computer vision, from its foundational concepts to advanced techniques. Students will learn to classify images, detect and segment objects, and understand 3D scenes. They will also explore advanced techniques like attention mechanisms and generative models. By the end of the course, students will be well-equipped to tackle real-world computer vision challenges. |

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| 1. **Course Contents** |
| Introduction and history of neural networks, Basic architecture of neural networks, Perceptron and Adaline (Minimum Error Learning) for classification. Basics of deep learning, learning networks, Shallow vs. Deep learning etc.; Machine learning theory – training and test sets, evaluation, etc. Selected topics from: Gradient descent (Delta) rule, Hebbian, Neo-Hebbian and Differential Hebbian Learning, Drive Reinforcement Theory, Kohonen Self Organizing Maps, Associative memory, Bi-directional associative memory (BAM), Energy surfaces, The Boltzmann machines, Backpropagation Networks, Feedforward Networks; Theory of Generalization; Multi-layer perceptrons, error backpropagation; Deep convolutional networks, Computational complexity of feed forward and deep convolutional neural networks; Unsupervised deep learning including auto-encoders; Deep belief networks; Restricted Boltzman Machines; Deep Recurrent Neural Networks (BPTT, LSTM, etc.); GPU programming for deep learning CuDNN; Generative adversarial networks (GANs); Sparse coding and auto-encoders; Data augmentation, elastic distortions, data normalization; Mitigating overfitting with dropout, batch normalization, drop-connect; Novel architectures, ResNet, GoogleNet, etc |

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| 1. **Course Learning Outcomes** | | | | | | |
| **CLOs** | **CLO Statement** | **BT Level** | **Mapping** | | | **% Weight** |
| **GAs** | **ACM KA** | **SGDs** |
| CLO1 | **Apply** the knowledge of core concepts, challenges, and historical developments of computer vision to analyze and address practical problems in the field. | C3 | GA2 | #9  IS | 9 | 50% |
| CLO2 | **Design**, deep learning models for image classification, object detection, and segmentation. | C6 | GA4 | 25% |
| CLO3 | **Apply** advanced techniques to complex computer vision problems. | C3 | GA5 | 25% |
| ***Note: On successful completion of course GA 1 (Academic Education) will automatically attain.*** | | | | | | |

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| 1. **Course Textbook / Reference Books and Supplementary Reading Material** | | | |
| **S No** | **Book Title** | **Author(s)** | **Edition/ publication year/publisher** |
|  | "Modern Computer Vision with PyTorch – Second Edition" | V Kishore Ayyadevara, Yeshwanth Reddy | 2nd  Year of Publication: 2024 |
|  | Deep Learning for Computer Vision" | Rajalingappaa Shanmugamani | Latest edition (specific number not provided)  Year of Publication: 2023 |
|  | Deep Learning for Vision Systems | Mohamed Elgendy | 1st  Year of Publication: 2024 |

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| 1. **CLO Outcome Based Assessment (OBA) Tentative** | | | | | | |
| **Assessment Tool** | | **CLO Mapped** | **CLO Marks** | **% Weight** | **Total Marks** | **Assessment Date** |
| **Quizzes**  **10** | Quiz #1 | *CLO1* | 10 | 30% | 3 | TBD |
| Quiz #2 | *CLO2* | 10 | 30% | 3 |  |
| Quiz #3 | *CLO3* | 10 | 40% | 4 |  |
| **Total Quizzes %** | | | **100%** | 10 |  |
|  | | | | | | |
| **Assignments**  **15** | Assignment #1 | *CLO1* | 3 | 20% | 3 |  |
| Assignment #2 | *CLO2* | 6 | 40% | 6 |  |
| Assignment #3 | *CLO3* | 6 | 40% | 6 |  |
|  |  | | | **100%** | 15 |  |
|  | | | | | | |
| **Midterm**  **25** | Midterm Q1 | *CLO1* | 10 | 40% | 10 |  |
| Midterm Q2 | *CLO1* | 5 | 20% | 5 |  |
|  | Midterm Q3 | *CLO2* | 5 | 20% | 5 |  |
|  | Midterm Q4 | *CLO2* | 5 | 20% | 5 |  |
|  | **Total Midterm %** | | | **100%** | **25** |  |
|  | | | | | | |
| **Project/CCP**  **10** | Project/CCP | *CLO1/2/3* | 10 |  |  |  |
|  | **Total Project /CCP %** | | | **100%** | **15** |  |
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| **Final Exam**  **40** | Final Exam Q1 | *CLO1* | 10 | 40% | 10 |  |
| Final Exam Q2 | *CLO2* | 10 | 40% | 10 |  |
| Final Exam Q3 | *CLO3* | 10 | 40% | 10 |  |
|  | Final Exam Q4 | *CLO3* | 10 | 40% | 10 |  |
|  | **Total Final Exam %** | | | **100%** | **40** |  |
| **100** | **Total Marls** | | | | **100** |  |
| ***Note: Please make sure every CLO must be assessed at least 3 time.*** | | | | | | |

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| 1. **Weekly Plan** | | | | |
| **Week** | **Lecture No** | **Topic Covered** | **CLO/1/2/3** | **Assessment Tool (Quiz#, Mid, Final)** |
| 1 | 1 | Introduction to Computer Vision |  |  |
|  | 2 | Problems faced, History and Modern Advancements |  |  |
| 2 | 3 | Image classification KNN |  |  |
|  | 4 | Hyper parameter tuning |  |  |
| 3 | 5 | Linear Classifier |  |  |
|  | 6 | SVM Loss (hinge loss) |  |  |
| 4 | 7 | Loss Function: Softmax Loss |  |  |
|  | 8 | Optimization SGD, |  |  |
| 5 | 9 | Ada ,Adam, |  |  |
|  | 10 | Activation Function |  |  |
| 6 | 11 | Neural Network |  |  |
|  | 12 | MLP related to Computer Vision |  |  |
| 7 | 13 | Backpropagation (assignment) |  |  |
|  | 14 | **Assignment of CCP / Project** |  |  |
| 8 | Mid Term | | | |
| 9 | 15 | Convolutional Neural Network, |  |  |
|  | 16 | CNN architecture (advance ) |  |  |
| 10 | 17 | Hardware and Software |  |  |
|  | 18 | NVIDIA, AMD, TPU |  |  |
| 11 | 19 | Training Neural Network |  |  |
|  | 20 | ReLU, Leaky ReLU, Exponential Linear Unit (ELU) |  |  |
| 12 | 21 | Data Preprocessing , Weight Initialization, Regularization Dropout |  |  |
|  | 22 | Recurrent Neural Network RNN |  |  |
| 13 | 23 | Attention Mechanism in CV |  |  |
|  | 24 | Vision Transformer |  |  |
| 14 | 25 | Visualization and understanding, object detection |  |  |
|  | 26 | Detection and segmentation |  |  |
| 15 | 27 | 3D vision, |  |  |
|  | 28 | Generative mode, Reinforcement |  |  |
| 16 | 29 | **Assessment of CCP / Project** |  |  |
| **17** | **Final Exam** | | | |

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| 1. **IU Assessment / grading Policy** | **Instructor grading for course \*** |
| Quizzes 10-15%  Assignments 10-15%  Projects/Presentation/CCP 0-10%  Mid Semester Examination/ 20-30%  End Semester Examination 40-50% | 10  15  10  25  40 |