SCHOOL OF ENGINEERING & TECHNOLOGY

COURSE FILE

Program: CSE
Course Code: CSE3023
Course Title: XAI: Explainable AI
Module Semester: Core Elective
Session: 7th Sem

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1. Course Details

- Course Code: CSE3023
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2. Vision, Mission of the University

Vision

BML Munjal University seeks to nurture ethical leaders who are skilled, knowledgeable and have the life skills required for leading their organizations to success. The university shall seek the advancement and dissemination of practically oriented knowledge benchmarked with the best global standards.

Mission

BML Munjal University aims to be a leading university for the quality and impact of its teaching, research and linkages with major stakeholders. The focus of the university is to find creative solutions to problems through application of knowledge. The university aims to create a talented community of students and faculty who excel in teaching, learning and research, in a creative and stimulating environment. The university will collaborate with other institutions for development of science, technology and arts in the global context.

3. Graduate Attributes

- Acquire and apply practical understanding of discipline knowledge.
- Demonstrate a sense of ethics and display excellence in both personal and professional life.
- Exhibit problem solving, critical thinking skills and investigative capability to address real world problems.
- Manifest leadership qualities and work effectively in teams across globally diverse environments.
- Be a lifelong learner with an entrepreneurial mindset to innovate in the constantly changing global scenario.
- Possess a strong sense of inquiry and design innovative solutions for positive societal impact.
- Be effective communicators and possess an empathetic outlook.

4. Vision, Mission of the School

Vision of School:

To be amongst the leading engineering schools of the country recognized globally for excellence in teaching and research with focus on experiential learning, innovation and entrepreneurship.

Mission of School:

* Providing high-quality learning experience to our students, preparing them to be global leaders, and contributing to the development of society through research, innovation, and entrepreneurship.
* Creating an inclusive and diverse learning environment that fosters creativity, critical thinking, and ethical values.
* Collaborating with industry, government, and other institutions to address complex societal challenges and promote sustainable development.

5. PEOs and POs & PSOs of the Program

Program Educational Objectives (PEO):

a) PEO 1: Identify real-life problems and develop creative and innovative hardware/software-based solutions.
b) PEO 2: Achieve professional development through self-learning to adapt to the technological changes in the ever changing field of computing.
c) PEO 3: Engage in life-long learning of computer engineering technologies, critical thinking and continuous ingenuity and apply them in real-life applications.
d) PEO 4: Accomplish leadership roles by imbibing ethics and professionalism with emphasis on sustainable development of the society.

Program Outcomes (PO):

e) PO1: Apply the foundational concepts of mathematics, science and computer engineering to find novel solutions for complex real-life engineering problems.
f) PO2: Identify, formulate, review literature and analyze complex computer engineering problems reaching substantiated conclusions and derive a coherent logic that can be implemented by computers.
g) PO3: Design analytical and computational models for solving complex engineering problems giving due consideration to issues related to public health and safety, cultural and societal constraints, and environmental concerns.
h) PO4: Use research-based knowledge, methods, tools and techniques for data collection, designing digital computing systems, analyzing and interpreting the results to provide substantiated conclusions.
i) PO5: Use appropriate tools to model complex computer engineering problems through identification of the limitations and creating solutions to predict the real-world phenomena.
j) PO6: Use appropriate contextual knowledge of computer engineering to review and assess societal, health, legal, cultural, safety and contemporary issues and rationalize the ensuing responsibilities towards the society.
k) PO7: Adopt computer engineering practices in congruence with societal need, understand the working practices and its impact on natural resources for sustainable development.
l) PO8: Use ethical principles to pursue excellence in developing computer engineering systems and behave appropriately to develop a reliable and trustworthy relationship with others.
m) PO9: Function effectively as a reliable and responsible individual, and as a member or leader in diverse computer engineering teams, and in multidisciplinary settings, thereby placing team goals ahead of individual interests.
n) PO10: Communicate effectively by capturing the desirable computer system requirements for preparation of specification documents, write clear and concise report such as laboratory files, research papers, thesis, and presentation materials.
o) PO11: Demonstrate knowledge of computer engineering and management principles for the completion of individual or group projects in multidisciplinary environments.
p) PO12: Recognize the evolving technological changes and engage as an independent and life-long learner in both computing and non-computing fields.

Program Specific Outcomes (PSO):

q) PSO1: Identify applicable tools and techniques related to data science practice such as data

collection, cleaning, analysis, modelling, evaluation and result interpretation and apply them for deriving hidden and meaningful patterns for appropriate actionable insights.

r) PSO2: Develop intelligent systems for various real-life domains like healthcare, transportation, finance etc. using Artificial Intelligence methodologies.

s) PSO3: Understand the foundational concepts and techniques to protect computing systems against constantly evolving cybersecurity threats and analyze security breaches and violations of cyber systems and networks to provide appropriate solutions.

t) PSO4: Design effective security systems to mitigate risks, threats and vulnerabilities for protecting the organizations against cyber threats.

6. Course Description and its objectives

The Explainable AI (XAI) course focuses on the principles and practices essential for understanding and interpreting AI systems. It covers foundational topics in machine learning, deep learning, generative AI, and large language models, emphasizing techniques like SHAP (SHapley Additive exPlanations), LIME (Local Interpretable Model-agnostic Explanations), saliency maps, and attention mechanisms. Students will learn to apply these tools to make complex AI models more transparent and interpretable, addressing both ethical and social implications.

This course integrates theoretical knowledge with practical applications, providing insights into the challenges and future directions of XAI, including its application to generative models and large language models. Students will gain skills in interpreting AI decisions, understanding various XAI techniques, and communicating findings to stakeholders. Through real-world case studies and practical exercises, participants will develop the expertise needed to enhance the transparency and accountability of AI systems.

7. Course Outcomes and CO-PO Mapping

Course Outcomes:

CO1: Understand what Explainable AI is, its scope, and impact on various domains.

CO2: Identify and evaluate the most used XAI techniques and algorithms.

CO3: Develop practical skills in Python for implementing and interpreting XAI methods and Interpret the results

CO- PO and PSO Mapping

CO/PO Mapping	P01	PO2	PO 3	P O 4	PO 5	P O 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO4
CO1			3	3	3	2				3		3	3	3		
CO2	2	3		3	3	2					1		3	3		
CO3		2	3	3	2			3	3	1		3	3	3	1	1

Experiential Learning Component:

8. Course Syllabus

Sr. No.	Content	CO	Sessions
1	INTRODUCTION TO XAI	1	5
2	INTERPRETABILITY METHODS & MODEL-AGNOSTIC XAI	1	4
3	INTERACTIVE MACHINE LEARNING TECHNIQUES & DEEP EXPLANATION TECHNIQUES	2	3
4	POSTHOC EXPLANATION APPROACHES & ETHICAL CONSIDERATIONS IN XAI	2	4
5	USER-CENTRIC XAI AND EVALUATION	3	3
6	GENERATIVE ADVERSARIAL NETWORKS (GANs) AND GENERATIVE AI (GenXAI) IN EXPLAINABLE AI	2	2

9. Learning Resources

Text Books:

✓ Denis Rothman. Hands-On Explainable AI (XAI) with Python. Packt 2020

✓ Molnar, Christoph. Interpretable machine learning. Lulu. com, 2020

✓ Biecek, Przemyslaw, and Tomasz Burzykowski. Local interpretable model-agnostic explanations (LIME). Explanatory Model Analysis Explore, Explain and Examine Predictive Models 1(2021): 107-124

✓ Kleppmann, Martin. Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. O'Reilly Media, Inc., 2017

Reference Links:

• Molnar, Christoph. Interpretable Machine Learning. Leanpub 2019 Online version publicly available at: https://christophm.github.io/interpretable-ml-book/scope-of-interpretability.html

• Schneider, Johannes. Explainable Generative AI (GenXAI): A Survey, Conceptualization, and Research Agenda. arXiv preprint arXiv:2404.09554(2024)

10. Weekly Timetable

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:15-10:10					
10:15-11:10					XAI: Explainable AI (CSE3023)
11:15-12:10	XAI: Explainable AI (CSE3023)		XAI: Explainable AI (CSE3023)		
12:15-13:10					
13:15-14:10		XAI: Explainable AI (CSE3023)		XAI: Explainable AI (CSE3023)	
14:15-15:10					
15:15-16:10					
16:15-17:10					
17:15-18:10					

11. Student List

uniqueId	studentName
210C2030002	Aayush Dubey
210C2030004	PelletiSujith Reddy
210C2030007	Malladi Sai Prabhas
210C2030010	SubhranshBehura
210C2030014	Abhimanyu Gulati

12. Internal Assessment Data

Component	Duration	Weightage	Evaluationweek	Remarks
Programming	2 Weeks	20%		Continuous Participation+Viva
Assignments		20%		After Mid Assess
QuiZS	20 mins	20%		Continuous
Project proposal, As per Literature survey, Methodology, and Preliminary Results		40%		During the Project-Based
End Term Project Evaluation				Universit norms

13. Weak Students Data

uniqueId	studentName	totalMarks	grade
210C2030002	Aayush Dubey	83	A+
210C2030004	PelletiSujith Reddy	78.5	B

14. Actions taken for weak students

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15. Marks Details

uniqueId	studentName	totalMarks	grade
210C2030002	Aayush Dubey	83	A+
210C2030004	PelletiSujith Reddy	78.5	B
210C2030007	Malladi Sai Prabhas	81.5	B+
210C2030010	SubhranshBehura	87	A+
210C2030014	Abhimanyu Gulati	47	R

17. Attendance Report

uniqueId	studentName	attendance
210C2030002	Aayush Dubey	88
210C2030004	PelletiSujith Reddy	90
210C2030007	Malladi Sai Prabhas	78
210C2030010	SubhranshBehura	82
210C2030014	Abhimanyu Gulati	68

Course Code: CSE3718	**Course Name:** Computer Vision	
Credits: 3 (2-0-2)	**Contact Hours:** 2 Hours Theory & 2 Hours Lab per week	
Batch: 2023, 7th Semester **Academic Year:** 2024-25	**Semester Duration:** 5th Aug 2024 to 6th Dec	
Course Faculty: Dr. Sukhandeep Kaur Email: Sukhandeep.kaur@bmu.edu.in Office: Cabin No. 12, 4th Floor, E2 Building	**Course Coordinator:** **Name:** Dr. Sukhandeep Kaur **Email:** Sukhandeep.kaur@bmu.edu.in **Office:** 12, IV Floor, E2 Building	

Aim of the course: The aim of this course is to help the students understand the fundamental concepts of computer vision and its applications. The course involves hands-on learning in the form of projects and practical sessions. At the end of the course, students will be able to develop efficient programs for numerous computer vision applications to solve real-world complex problems.

Course Overview and Context: In an increasingly visual world, computer vision has emerged as a critical field at the intersection of computer science, artificial intelligence, and image processing having numerous real-world applications. The course will explore various applications of computer vision, such as facial recognition, autonomous vehicles, medical image analysis, and augmented reality, demonstrating its relevance across diverse industries. This course provides a comprehensive exploration of the fundamental concepts, techniques, and practical applications of computer vision. Upon successful completion of the course, students will have the knowledge and skills needed to work on cutting-edge computer vision projects and contribute to the advancement of this dynamic field.

Course Outcomes (CO): At the end of the course the students should be able to do the following:

CO1: Understand the theoretical and practical aspects of computer vision.

CO2: Apply and demonstrate the various computer vision algorithms and techniques to different domains.

CO3: Design framework/technique/algorithm to solve real-life problems using computer vision methods

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Topics of the course:

	Topics	CO	No of Sessions
	Introduction : Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image, Analysis, Bio-metrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.	CO1, CO2	2 sessions

	Image formation, camera model, Projective geometry, Homographies, Geometric transformations, The Pinhole camera model, camera calibration, camera extrinsic and intrinsic parameters, Radiometry and reflectance, BRDF, color and lighting. Filters, image pyramids,	CO1, CO2,	4 sessions
	Numerical representation of images, Image stitching, Image-Processing Python Libraries Used in computer vision: OpenCV, Pillow/PIL, SciPy,Scikit-Image etc.	CO1	3 sessions
	Image Processing, Feature extraction, and understanding feature engineering, shape, histogram, color, spectral, texture, Feature analysis, feature vectors, distance /similarity measures, data preprocessing, Edge detection, Edge detection, Edge detection performance, Hough transform, corner detection. Edges - Canny, Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG and Gaussian derivative filters and DWT.	CO1,CO2	5 sesssions
	Motion Estimation : Stereo Vision: two view and multi view stereo, Multiview geometry, epipolar geometry, Structure from motion, Optical Flow and Motion Analysis, parametric motion. Applications in terms of video stabilization, object tracking.	CO2,CO3	3 sessions
	Object Recognition: Traditional Methods: HoG/SIFT features, Bayes classifiers, SVM classifiers; Object Recognition: Deep Learning Methods, Deep neural networks, classification networks, object proposal networks.	CO2, CO3	3 session
	Depth estimation, 3D Reconstruction, and Shape Representation, Diffusion models	CO2	4 sessions
	Segmentation: Contour based representation, Region based representation, Deformable curves and surfaces, Region Growing, Various methods of image segmentation, Semantic Segmentation.	CO2, CO3	4sessions
	Shape Representation and Segmentation: Contour based representation, Region based representation, Deformable curves and surfaces, Region Growing, Various methods of image segmentation, Semantic Segmentation.	CO2, CO3	3 sessions
	Image Understanding and Computer Vision Applications: Pattern recognition methods, Face detection, Face recognition, 3D shape models of faces Application: Surveillance – foreground-background separation –human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians. Learn various application computer vision techniques.	CO3,	4 sessions

CO/PO Mapping:

** 1- low, 2-moderate, 3-high*

CO/PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3			2	2		1		1	1			2			
CO2		3		2	3	3	2		2		2		2			
CO3	3	2	3	2	3	3	1		3	3	3	2		2		

Learning Resources:

Text Book:

1. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA), 2nd Edition, Springer, 2022

Reference books:

2. Solem, Jan. Programming Computer Vision with Python: Tools and algorithms for analyzing images. " O'Reilly Media, Inc.", 2012.
3. Hartley and Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2004
4. Forsyth and Ponce, Computer Vision: A Modern Approach, Prentice Hall, 2002
5. Palmer, Stephen E. Vision science: Photons to phenomenology. MIT press, 1999.
6. Computer Vision and Image Processing, Adrian Low, Second Edition, B.S.Publications
7. D. Forsyth and J. Ponce, Computer Vision - A modern approach, Prentice Hall

Reference Links: These are a few online resources available for further studies:

i) https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

ii) https://www.coursera.org/learn/computer-vision-basics

iii) https://www.youtube.com/@firstprinciplesofcomputerv3258

Other reference material will be provided as required.

Note: Instructors will regularly post the necessary learning resources such as lecture resources to the online course management portal i.e. Maitri/Google-classroom.

Percentage of Course covered in the suggested Book: 100%

Assessment Pattern: The final grade will be determined by the marks or grades earned during the project's phase-wise evaluations and the end-term assessment. Grading will be conducted using the relative grading method outlined in the university's academic regulations. To be eligible for grading, students must achieve a minimum of 40% of the total marks upon completing all assessments listed in the table below:

Evaluation Component	Weightage (%)	Evaluation Schedule	Rubrics
Assignments/ Mid sem (Experiential Learning)	20%	4th week of September	Written or Viva

Project Phase Evaluation -1	20%	Continues	Project proposal (5) Literature survey (10), Methodology (5)
Quiz	20%	3rd week of October	Topics to be covered will be announced in the class.
End Term Evaluation(Project Evaluation -2)	40%		Project-Based (Panel Evaluation) Publication and report (10) Methodology (10) Results(10) Question(10)

- All evaluations will be based on the work presented by the students as well as the questions asked, or the problems given to code.
- Cases of AI-generated code or plagiarism will be taken seriously and reported according to the university's policy on Unfair Means (UFM). It is essential that all work is original and adheres to academic integrity.
- There is a mandatory requirement to upload the project to a public repository on GitHub.

Experiential Learning (30%):

In this course, students are required to provide the use cases of computer vision techniques to implement something new as part of a project that has not been done before in the literature, either by proposing novel improvements to an existing method, applying existing methods to new types of data, or proposing a new task or dataset. The students are also expected to implement and show the results of the proposed solution or attempt to re implement and improve on a research paper on a topic of their choice. Hence, this course contributes 70-80% for experiential learning.

Student Responsibilities:

- Attend lectures and do the work Lab Assignments as per instructions.
- Participate in the discussions/assignments held during classes.
- Check announcements on the LMS and emails regularly.
- Submit the assigned task on time.
- Regularly check marks on the LMS to ensure they are up to date.
- Participate in class and take necessary actions to grasp the material. Asking questions is encouraged.
- Communicate any concerns by speaking directly with the instructor.

Attendance Policy: Students are expected to attend classes regularly. Failure to follow the classes regularly and adhere to the expected attendance percentage will result in losing quiz/lab marks and a reduction of the grade as per the University's grading policy.

Recourse Examination Policy: In case a student fails the course, a one-time recourse is permitted as per the academic regulations of the University. Recourse is allowed only for the End Semester examination.

Make-up policy: No make-up exam will be conducted for unexcused absences. The faculty needs to be informed in advance in case the student is not going to appear for any evaluation component, and it is at the discretion of the faculty to sanction makeup for an evaluation component.
Behavior Expectations: No mobile phones and other distractive gadgets are permitted in the class.
Academic Dishonesty/Cheating/Plagiarism: Plagiarism and dishonesty in any form in any evaluation component will lead to appropriate disciplinary action.