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| IQRA University (IU) | | |
| Faculty of Engineering Sciences and Technology (FEST) | | |
| Computer Science Department (CS) | | |
| Course Code | Course Name | Credit Hr |
| AIC331 | KNOWLEDGE REPRESENTATION AND REASONING | 2+1 |

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| 1. Basic Information | | | |
| Instructor | Dr. Lubna Aziz | Designation | Assistant professor |
| Prerequisite(s) | CMC331 | Semester | Fall 2024 |
| Email | Lubna.aziz@iqra.edu.pk | Phone | NA |
| Consulting Hours | Wednesday(12:00 – 14:00) | Office Location | First Floor Faculty offices |

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| 1. **Course Objective(s)** |
| Knowledge representation is one of the fundamental areas of Artificial Intelligence. It is the study of how knowledge about the world can be represented and manipulated in an automated way to enable agents to make intelligent decisions. This course will provide an overview of existing knowledge representation frameworks developed within AI including but not limited to propositional and first-order logic, ontologies, planning, reasoning and decision making under uncertainty. The assignments component of the course would provide hands-on experience of software like Prolog, Protégé, probabilistic reasoning APIs and tools to support complex decision making. It is expected that after completing this course, students will understand (a) the foundations of Knowledge Representation & Reasoning and (b) which tools and techniques are appropriate for which tasks. |

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| 1. **Course Contents** |
| Propositional Logic, First-order Logic, Horn Clauses, Description Logic, Reasoning using Description Logic, Forward and Backward Chaining in Inference Engines, Semantic Networks, Ontologies and Ontology Languages, Logical Agents, Planning, Rule-based Knowledge Representation, Reasoning Under Uncertainty, Bayesian Networks Representation, Inference in Bayesian Networks, Fuzzy Logic, Inference using Fuzzy Rules, Markov Models, Commonsense Reasoning, Explainable AI. |

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| 1. **Course Learning Outcomes** | | | | | | |
| **CLOs** | **CLO Statement** | **BT Level** | **Mapping** | | | **% Weight** |
| **GAs** | **ACM KA** | **SGDs** |
| CLO1 | **Understand** the fundamental principles underlying knowledge representation with challenges and reasoning under uncertainty and deterministic scenarios. | C2 | GA2 | #9  IS | 4 & 9 | N.A |
| CLO2 | **Analyze** diverse scenarios to determine the most suitable knowledge representation frameworks and apply them effectively. | C4 | GA3 | N.A |
| CLO3 | **Synthesize** existing knowledge representation frameworks to create hybrid approaches for resolving intricate decision-making challenges. | C6 | GA4 | N.A |
| ***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** |
|  | Explainable AI for Practitioners" | Patrick Hall, Navdeep Gill, and Nicholas Schmidt | (1st Edition, published in 2023). |
|  | "Knowledge Representation and Reasoning | Ronald Brachman and Hector Levesque | (1st Edition, published in 2004). |
|  | "Knowledge Representation, Reasoning, and Declarative Problem Solving | Chitta Baral | (1st Edition, published in 2003) |

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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* | 10 | 20% | 3 |  |
| Assignment #2 | *CLO2* | 10 | 40% | 3 |  |
| Assignment #3 | *CLO2* | 10 | 40% | 4 |  |
|  |  | | | **100%** | 10 |  |
|  | | | | | | |
| **Midterm**  **25** | Midterm Q1 | *CLO1/2/3* | **5** | 20% | 5 |  |
| Midterm Q2 | *CLO1/2/3* | 5 | 20% | 5 |  |
|  | Midterm Q3 | *CLO1/2/3* | 5 | 20% | 5 |  |
|  | Midterm Q4 | *CLO1/2/3* | 10 | 40% | 10 |  |
|  | **Total Midterm %** | | | **100%** | **25** |  |
|  | | | | | | |
| **Project/CCP**  **10** | Project/CCP | *CLO1/2/3* | 10 |  |  |  |
|  | **Total Project /CCP %** | | | **100%** |  |  |
|  | | | | | | |
| **Final Exam**  **40** | Final Exam Q1 | *CLO3* | 10 | 25% | 10 |  |
| Final Exam Q2 | *CLO1* | 10 | 25% | 10 |  |
| Final Exam Q3 | *CLO2* | 10 | 25% | 10 |  |
|  | Final Exam Q4 | *CLO3* | 10 | 25% | 10 |  |
|  | **Total Final Exam %** | | | **100%** |  |  |
| **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 | Propositional Logic |  | Midterm |
| 2 | Tableau Method |  | Midterm |
| 2 | 3 | Refutation Resolution Methods |  | Midterm |
| 4 | First-order Logic, Horn Clauses |  |  |
| 3 | 5 | Syntax and semantic |  | Quiz1/ Assignment 1 |
| 6 | Description Logic, Reasoning using Description Logic |  |  |
| 4 | 7 | Forward and Backward Chaining in Inference Engines |  |  |
| 8 | Forward and Backward Chaining in Inference Engines (Conti..) |  |  |
| 5 | 9 | Semantic Networks, |  |  |
| 10 | Ontologies and Ontology Languages |  |  |
| 6 | 11 | Logical Agents, Plaining |  | Assignment2 |
| 12 | Explainable AI |  |  |
| 7 | 13 | Reasoning Under Uncertainty |  |  |
| 14 | LIME |  |  |
| 15 | **CCP/ Assignment and Discussion** |  |  |
| 8 | **Midterm Exam** | | | |
| 9 | 16 | Bayesian Networks Representation |  |  |
| 17 | SHAP / Integrated Gradient |  |  |
| 10 | 18 | Inference in Bayesian Networks |  |  |
| 19 | Smooth Gradient |  | Assignment 3 |
| 11 | 20 | Rule-based Knowledge Representation |  |  |
| 21 | Explainable Gradient |  | Quiz2 |
| 12 | 22 | Fuzzy Logic |  |  |
| 23 | Open XAI |  |  |
| 13 | 24 | Inference using Fuzzy Rules |  | Quiz3 |
| 25 | Casual and Algorithmic resource |  |  |
| 14 | 26 | Markov Models, Commonsense Reasoning, |  |  |
| 27 | Attention Not Explainable |  |  |
| 15 | 28 | Convolutional Attention |  |  |
| 29 | **Submission of CCP / Project** |  |  |
| 16 | 30 | **Continue ….** |  |  |
| **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 |