Pokhara University
Faculty of Science and Technology

Course No.: CMP 346 (3 Credits)	Full marks: 100
Course title: **Artificial Intelligence (3-1-3)**	Pass marks: 45
Nature of the course: Theory and Practical	Total Lectures: 45 hrs
Level: Bachelor	Program: BE (Computer)

1. Course Description

This course is designed to provide an in-depth introduction to the field of Artificial Intelligence (AI). It covers the fundamental concepts, methodologies, and applications of AI, including problem-solving by searching, knowledge representation, reasoning and machine learning. Students will also explore ethical issues.

2. General Objectives

- To provide the students with foundational principles and techniques of Artificial Intelligence.
- To develop the skills and ability in students to formulate AI-based solutions to real-world problems.
- To acquaint the students with the knowledge of various AI domains such as machine learning, expert systems, neural network and fuzzy systems.
- To provide the students with the knowledge to critically evaluate the ethical implications of AI and its impact on society.

3. Methods of Instruction

Lecture, Discussion, Readings, Practical works and Project works.

4. Contents in Detail

Specific Objectives	Contents

• Explain artificial intelligence, its approaches and its foundations. • Critically evaluate the ethical implications of AI and its impact on society.	**1. Introduction to Artificial Intelligence (4 hrs)** 1.1. Intelligence 1.1.1. Types of Intelligence 1.1.2. Components of Intelligence 1.2. Artificial Intelligence 1.2.1. Approaches of AI 1.2.1.1. Acting Humanly 1.2.1.2. Thinking Humanly 1.2.1.3. Thinking Rationally 1.2.1.4. Acting Rationally 1.2.2. Foundations of AI 1.2.3. History of AI 1.2.4. Risk and Benefits of AI 1.3. Ethics and Societal Implications 1.3.1. Ethical Implications of AI 1.3.2. AI and Society: Work and Automation, Employment, Privacy and Security 1.3.3. Governance and Regulation
● Design and implement intelligent agents.	**2. Intelligent Agents (5 hrs)** 2.1. Agents and Environments 2.2. Concept of Rationality 2.2.1. Performance Measures 2.2.2. Rationality and Rational Agent 2.3. Task environment and its properties 2.4. Structure of Agents 2.4.1. Agent programs 2.4.2. Types of agent programs 2.5. Learning Agents
● Formulate the real world problems and apply the search algorithms to solve them.	**3. Problem Solving and Search Algorithms (10 hrs)** 3.1. Problem Solving 3.1.1. Problem Solving Agents 3.1.2. Problem solving process 3.1.3. Production System 3.1.4. Well-defined and ill-defined problems 3.1.5. Problem formulation 3.2. Search Algorithms 3.2.1. Uninformed Search 3.2.1.1. Breadth- First Search 3.2.1.2. Depth-First Search 3.2.1.3. Iterative Deepening Search 3.2.2. Informed Search 3.2.2.1. Heuristics 3.2.2.2. Greedy Best-First Search 3.2.2.3. A* Search 3.3. Local Search and Optimization Problems 3.3.1. Hill-Climbing Search and its problems (Local maxima, plateaus, and ridges) 3.3.2. Simulated Annealing

	3.3.3. Genetic Algorithms 3.3.4. Gradient Descent 3.4. Adversarial Search and Game Playing 3.4.1. Minimax algorithm 3.4.2. Alpha-beta pruning 3.5. Constraint Satisfaction Problems 3.5.1. Representation of CSPs 3.5.1.1. Variables 3.5.1.2. Domains 3.5.1.3. Constraints 3.5.2. Search Algorithms for CSPs 3.5.2.1. Backtracking search 3.5.2.2. Constraint propagation 3.5.3. Optimization Technique: Min-Conflicts Heuristic1
• Represent the knowledge of a domain and apply inference rules to draw conclusions.	**4. Knowledge Representation and Reasoning (10 hrs)** 4.1. Propositional Logic 4.1.1. Syntax 4.1.2. Semantics 4.1.3. Inference in Propositional Logic 4.1.4. Conjunctive Normal Form (CNF) 4.1.5. Resolution Theorem Proving 4.1.6. Limitations of Propositional Logic 4.2. Predicate Logic 4.2.1. Syntax 4.2.2. Semantics 4.2.3. Inference in Predicate Logic 4.2.4. Resolution in Predicate Logic 4.3. Reasoning Under Uncertainty 4.3.1. Probabilistic Reasoning 4.3.1.1. Bayesian Networks 4.3.2. Probabilistic reasoning over time 4.3.2.1. Hidden Markov Models 4.4. Other Approaches to Knowledge Representation 4.4.1. Semantic Nets and Frames 4.4.2. Rule-based Representation 4.4.3. Ontological-Based Representation
• Develop and apply the machine learning algorithms to classify and cluster the data. • Design an artificial neural network that can learn.	**5. Machine Learning (6 hrs)** 5.1. Definition and Evolution of Machine Learning 5.2. Learning by Analogy 5.3. Explanation-based learning 5.4. Supervised Learning Algorithms 5.4.1. Classification and Regression 5.4.2. Linear regression 5.4.3. K-Nearest Neighbour 5.5. Unsupervised Learning Algorithms 5.5.1. Clustering 5.5.2. K-means Clustering

	5.6. Artificial Neural Network 5.6.1. Biological Inspiration 5.6.2. Basic Components of ANN 5.6.3. Training Neural Networks 5.6.3.1. Forward Propagation 5.6.3.2. Loss Function 5.6.3.3. Backward Propagation 5.6.3.4. Learning Rate 5.6.4. Single-Layer Perceptron 5.6.5. Multi-Layer Perceptron
• Apply the fuzzy logic for reasoning in an expert system.	**6. Fuzzy Logic (5 hrs)** 6.1. Classical vs Fuzzy Logic 6.2. Fuzzy Sets and Membership Functions 6.3. Fuzzy Operations 6.4. Fuzzy Rule-Based Systems 6.5. Fuzzification and Defuzzification 6.6. Fuzzy Inference System: Mamdani
• Design and develop an expert system to solve a real-world problem.	**7. Expert System (5 hrs)** 7.1. Definition and History of Expert System 7.2. Architecture of Expert Systems 7.3. Knowledge Representation in expert system 7.3.1. Logic based representation 7.3.2. Rule-based system 7.3.3. Semantic networks 7.3.4. Ontology-based Systems 7.3.5. Frame-based Systems 7.4. Inference Mechanisms 7.4.1. Forward Chaining 7.4.2. Backward Chaining 7.5. Knowledge Acquisition and Learning 7.6. Applications of Expert Systems

5. Practical Works

Laboratory work of 45 hours per group of maximum 24 students should cover implementation of the following lab works:

SN	Implementation Description
1	Implement search algorithms (e.g., BFS, DFS, A*) in Python.
2	Develop a simple expert system using rule-based reasoning/fuzzy logic.
3	Implement and evaluate classification algorithms (e.g. linear regression and k-NN) and clustering algorithms (e.g. k-means) using Python.

4	Build and train single layer and multi-layer perceptrons.
5	Implement the fuzzy logic for reasoning in an expert system.

Students should submit a project work that uses all the knowledge obtained from this course to solve any problem chosen by themselves. The marks for the practical evaluation must be based on the project work submitted by students.

6. List of Tutorials

The various tutorial activities that suit your course should cover all the content of the course to give students a space to engage more actively with the course content in the presence of the instructor. Students should submit tutorials as assignments or class works to the instructor for evaluation. The following tutorial activities of 15 hours per group of maximum 24 students should be conducted to cover the content of this course:

A. Discussion-based Tutorials: (3 hrs)
   a. Evolution of Artificial Intelligence (Class discussion).
   b. AI and Society: Employment, Privacy and Security (Class discussion).

B. Problem solving-based Tutorials: (6 hrs)
   a. Apply a search technique to solve a real world problem.
   b. Design and develop a simple expert system that solves a real world problem.

C. Review and Question/Answer-based Tutorials: (6 hrs)
   a. A detailed case study on any one fuzzy system. (Class Presentation)
   b. Students ask questions within the course content, assignments and review key course content in preparation for tests or exams.

7. Evaluation System and Students' Responsibilities

Evaluation System

The internal evaluation of a student may consist of assignments, attendance, internal assessment, lab reports, project works etc. The internal evaluation scheme for this course is as follows:

Internal Evaluation	**Weight**	**Marks**	**External Evaluation**	**Marks**
Theory		30	Semester-End examination	50
Attendance & Class Participation	10%			
Assignments	20%			
Presentations/Quizzes	10%			
Internal Assessment	60%			
Practical		20		

Attendance & Class Participation	10%			
Lab Report/Project Report	20%			
Practical Exam/Project Work	40%			
Viva	30%			
Total Internal		50		
Full Marks: 50 + 50 = 100				

Student Responsibilities

Each student must secure at least 45% marks separately in internal assessment and practical evaluation with 80% attendance in the class in order to appear in the Semester End Examination. Failing to get such a score will be given NOT QUALIFIED (NQ) to appear for the Semester-End Examinations. Students are advised to attend all the classes, formal exam, test, etc. and complete all the assignments within the specified time period. Students are required to complete all the requirements defined for the completion of the course.

8. Prescribed Books and References

Text Books

1. Russell, S. J., & Norvig, P. (2022). *Artificial intelligence: a modern approach.* Pearson.

References

1. Jurafsky, D., & Martin, J. H. *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition*. Pearson.
2. Bird S., Klein E., & Loper E. (2009). *Natural Language Processing with Python*. O'Reilly Media.
3. Bishop, C. M. (2006). *Pattern recognition and machine learning*. Springer.