SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

Year: B. Tech III (Semester VI)

Subject Name: Knowledge Representation and Reasoning **Subject Code:** BTAI13602
Type of course: Professional Core course
Prerequisite (if any): Data Structures, Discrete Mathematics

Rationale: Knowledge representation and reasoning is the area of Artificial Intelligence (AI) concerned with how knowledge can be represented symbolically and manipulated in an automated way by reasoning programs. This course provides study of AI that is concerned with thinking, and how thinking contributes to intelligent behavior.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments / projects / open book tests / closed book tests) CA2: Sincerity in attending classes / class tests / timely submissions of assignments / self-learning attitude / solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work / Quality of work submitted / Active participation in lab sessions / viva on practical skills learned in course.

Contents:

Sr. No.	Contents	Total Hrs
1.	**Introduction** – Knowledge Representation and Mappings, Approaches to knowledge representation, Issues in Knowledge Representation	**04**
2.	**Logical Reasoning**- Knowledge-based Agents, The Wumpus World Example, Propositional Logic, Syntax and Semantics, Logical Reasoning- Entailment and Inference, soundness, completeness, Theorem Proving-Validity, Satisfiability, Modus Ponens Inference rules, Resolution in Propositional Logic, horn clause, conjunctive normal forms, Forward and backward chaining, Davis-Putnam algorithm (DPLL) and WalkSAT algorithms for propositional model checking, limitations of Propositional Logic, Syntax and Semantics of First Order Logic, Quantifiers, Computable functions, Resolution refutation, Unification	**12**
3.	**Representing Knowledge Using Rules:** Forward and Backward Chaining Rule Systems, Basic Matching, index operation working memory elements, Complex and Approximate Matching, Conflict Resolution, RETE network, Examples **Expert System:** Representing and using domain knowledge, Expert system shells, explanation, knowledge Acquisition	**08**
4.	**Uncertain Knowledge and Reasoning:** **Quantifying Uncertainty:** Acting under Uncertainty, The Basic Probability notation, inference using full joint distributions, Independence, Bayes' Rule and its Use, **Probabilistic Reasoning:** the semantics of Bayesian Networks, Conditional Independence, Markow blanket, Exact inference in Bayesian Networks, Inference by enumeration, the	**08**

	variable elimination algorithm, Representing ignorance: Dempster-Shafer theory, Representing vagueness: Fuzzy sets and Fuzzy logic	
5.	**Structured Representation of Knowledge and Ontology:** Semantic networks, Frames, Conceptual Dependency, Script, CYC, categories and objects, taxonomic hierarchy, event calculus, modal logic, description logics, Resource Description Framework(RDF), Web Ontology Language (OWL), Non-monotonic reasoning, default reasoning, Abduction, minimalist reasoning, Closed World Assumption, Circumscription, Auto epistemic Logic	**07**
6.	**Logic Programming in Prolog:** Introduction, Syntax, Variables, Control Structures, Arithmetic Operators, representing facts and rules, matching in prolog, negation as failure, search strategy in prolog, backtracking, cut fail and repeat predicate, basic List manipulation operations,	**06**

Suggested Specification table with Marks (Theory): (For B. Tech only)

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	20	15	10	0	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

Sr no	**Title of book /article**	**Author(s)**	**Publisher and details like ISBN**
1.	Knowledge Representation and Reasoning	Ron Brachman and Hector Levesque	Morgan Kaufmann
2.	Artificial Intelligence: A Modern Approach (Third Edition)	Stuart J. Russell, Peter Norvig	Pearson
3.	Artificial Intelligence	Elaine Rich And Kevin Knight	Tata McGraw-Hill
4.	Introduction to Turbo PROLOG	Carl Townsend	BPB Publications
5.	PROLOG Programming For Artificial Intelligence	Ivan Bratko	Addison-Wesley

Note: Students should refer to the latest editions of books

Course Outcomes:

Sr. No.	**CO statements**	**Marks % weightage**
CO-1	Understand various research issues and approaches in knowledge representation.	10%
CO-2	Acquire theoretical knowledge about principles for logic-based representation and reasoning.	25%
CO-3	Ability to understand approaches to handle uncertain or incomplete knowledge	15%
CO-4	Ability to understand different knowledge structures, ontology, and nonmonotonic	15%

	reasoning	
CO-5	Ability to implement Expert System to solve various problems and understand matching and conflict resolution in rule-based system	15%
CO-6	Ability to implement various list manipulation programs using Prolog	20%

List of Open learning website:

- NPTEL online course: Artificial Intelligence: Knowledge Representation and Reasoning https://nptel.ac.in/courses/106106140

List of Open Source Software:

- Python
- WEKA

List of Suggested Experiments:

1. To Study Knowledge representation using rules and its complex matching process with the help of Eliza Chabot. Document your study and understanding.
2. Write Prolog Program to explore basic Prolog syntax and structure using simple facts and Queries.
3. Write a PROLOG program for defining various facts about kinship relations.
4. Write Prolog Program to Explore operators and input output.
5. To Study Fail, Cut and repeat predicates in PROLOG and demonstrate using programs
   (a) FAIL predicate. (b) CUT predicate (c) logon routine using repeat predicate
6. *Translate these sentences into formulas in predicate logic and write a suitable* PROLOG program.
   1. Marcus was a man.
   2. Marcus was a Pompeian.
   3. All Pompeians are Romans.
   4. Caesar was a ruler.
   5. All Romans are either loyal to Caesar or hated him.
   6. People only try to kill rulers they are not loyal to.
   7. Marcus tried to kill Caesar.

   Verify whether "Marcus loyal to Caesar? in goal state.
7. Write prolog programs for following list manipulation operations.
   (a) Check the membership of an item in a given list.
   (b) Find the size of a list

(c) Find the nth element of a given list.
(d) Find the last element of a given list.
(e) Delete an element in a given list.
(f) Append two given lists.
(g) Reverse a given list
(h) Merge two sorted lists and generate a new sorted list.
(i) Find the Sum of elements of a List.
(j) To count vowels in a list of characters.

8. Write a PROLOG program to implement an expert system for medical diagnosis.
9. Implement naive Bayes Algorithm in python
10. Demonstrate inferencing with the Bayesian network using WEKA tool.
11. Demonstrate how to describe domain knowledge using description logic with the help of Web Ontology Language (OWL).
12. Demonstrate how to express knowledge using Resource Description Framework (RDF) data model.